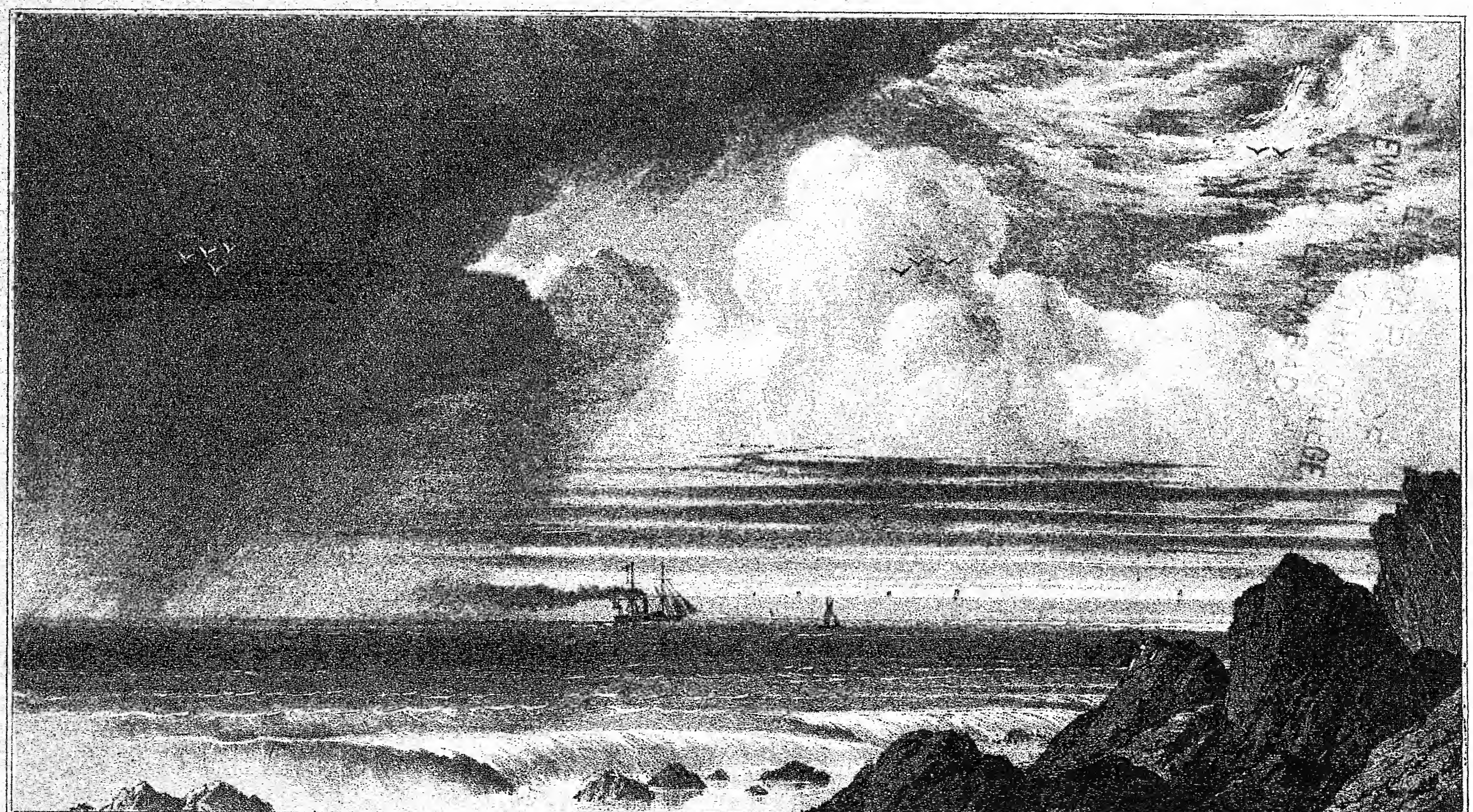
FORMS of CLOUDS

PLATE XII.



J. FERGUSON LITH.

Lith^d. at the Topographical Department WAR OFFICE
COL. SIR H. JAMES. R.E. F.R.S. M.R.I.A. &c. Director.

Stratus — Cirrus — Cumulus — Nimbus

Stephen Elwood M.B. A.B. T.C.D.
L.R.C.S.I. L.M. R.D.
Staff Assist Surgeon.
July 1862.

INSTRUCTIONS

FOR TAKING

Wm. J. P. Morrison
1871

METEOROLOGICAL OBSERVATIONS;

WITH

TABLES FOR THEIR CORRECTION,

AND

NOTES ON METEOROLOGICAL PHENOMENA.

DRAWN UP,

BY ORDER OF THE SECRETARY OF STATE FOR WAR,

BY

COLONEL SIR HENRY JAMES, ROYAL ENGINEERS,
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FOR HER MAJESTY'S STATIONERY OFFICE.
1861.

N.B.—With the view of rendering these Instructions more generally useful, I have added descriptions and drawings of a marine barometer and of two hydrometers, which will be found at the end of the volume.

H. J.

February 14th, 1861.

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N.B.—The Plates have been drawn by Mr. James Ferguson *and* Corporal Joseph Downing, Royal Engineers.

INSTRUCTIONS

FOR TAKING

METEOROLOGICAL OBSERVATIONS.

Section I.

PREFACE.

In compliance with the orders of General Sir John F. Burgoyne, Inspector-General of Fortifications, I drew up the "Instructions "for taking Meteorological Observations at the principal Stations "of the Royal Engineers," which were printed in the year 1851.

Since that time the construction of many of the instruments has been altered and improved, and as the number of copies of the instructions then printed has been exhausted, I have been directed by the Right Hon. Sidney Herbert, Secretary of State for War, to draw up a revised copy of instructions for taking meteorological observations for the use of the Royal Engineers and the Officers of the Army generally, who take or may desire to take observations at any of our military stations.

To these instructions I have added the tables which are necessary for the correction of the observations, so that it may be unnecessary to refer to any other source of information for reducing the observations to the form required.

I have also added a few remarks on some of the more remarkable phenomena connected with the atmosphere, in the hope of interesting the Officers in a science which requires the co-operation of numerous accurate observers in all parts of the world for its full elucidation.

In 1855 I published "Abstracts of the Meteorological Observa- "tions which had been taken in the year 1853-4 by the Royal "Engineers at the following—

1. *Stations.*

Bahama.	Jamaica.
Barbadoes.	Kingston.
Bermuda.	Malta.
Cape of Good Hope.	Mauritius.
Ceylon.	Newfoundland.
Corfu.	New South Wales.
Gibraltar.	New Zealand.
Guernsey.	Quebec.
Halifax.	St. Helena.
Hong Kong.	

and I am now preparing for publication abstracts of the observations taken at those stations during the last five years, as well as of the observations taken at several home stations which have since been established.

We shall thus furnish not only correct information as to the climate of each place at which our garrisons are stationed, but also accurate data for the discussion of the many great physical problems connected with the science of meteorology.

2. Proposed Congress of Meteorologists.

This science will never receive the full benefit of the numerous observations which are now taken, until that co-operation and mutual interchange of the results obtained in each country, which is so ardently desired by the most distinguished meteorologists throughout the world, is established.

When we consider what a vast number of established observatories there are in almost every country, which are supported at the cost of their respective governments, and how simple and inexpensive it would be to establish such a mutual interchange of the results obtained in each country on an uniform system, and reduced to common standards of measure; it is greatly to be regretted that no one of sufficient energy and ability has taken this subject up, with the view of bringing into operation a system which every Government and every man of science must desire to see established.

It is true that several Governments, including our own, are most liberal in printing the meteorological observations taken at the several Government observatories, and that there is a liberal distribution of copies of them, but still these are accessible but to few, and when obtained they are written in so many languages and measures as to discourage the most ardent lovers of science to undertake the labour of translation and reduction to common standards, as a necessary preliminary to the discussion of the great cosmical laws which govern atmospheric phenomena.

If a congress of meteorologists from the principal States of Europe and America were to meet and agree upon a *form of abstract* for the observations taken in each country, and upon *common measures* in which the abstracts should be printed (as well as in the language and measures of the country in which the observations were taken), and these abstracts were interchanged, I feel certain that the science of meteorology would be more advanced in a few years than it has been for many centuries past, or is likely to be under the present system for many centuries to come. Nor can it be doubted that the Governments from which we now receive no observations would readily join in working out a system from which the local observations would derive such a great increase in value.

If we take, for example, the course of the great revolving storm which passed over Southampton (on the 25th October 1859) as a subject of investigation, and we had the observations from all parts

of the world to refer to, we could trace with the greatest precision the point at which it originated, the course it followed, and where it died out, or the great current of the atmosphere; so again with reference to those great atmospheric waves which traverse the surface of the globe at intervals, and what may also be called the great waves of heat and cold, whence do they proceed, and what directions do they take? Without the means of solving such questions as these, amongst very many others, we cannot hope to arrive at any accurate results as to the causes which produce such phenomena, or give instruction by which their effects may be in some degree mitigated, if not avoided.

A conference of meteorologists was assembled at Brussels in the year 1853, which I attended with the late Admiral Beechy, as the representatives of England, and at this conference an uniform system for the observations to be taken at sea was agreed upon, and adopted by our own and almost every other Government in Europe and America. I anticipate very valuable results from the system now followed at *sea* by so many nations, but we can never derive the full benefit of these observations, unless a similar arrangement be adopted for the observations taken on *land*.

The following letter from Mons. Le Verrier to Mr. Airy, proposing an interchange, twice a day by telegraph, of the meteorological observations taken at some of our seaports, for those taken at stations on the coast of France, opens up so great and important a question that I have thought it better to reprint the letter at length; and I am glad at the moment of sending this work to the press to see a system of co-operation established, which I trust will lead to that further and more general combination amongst meteorologists which I have so long advocated.

H. James, Col. R.E.

Ordnance Survey Office, Southampton,
April 30, 1860.

OBSERVATOIRE IMPÉRIAL DE PARIS.

Service Météorologique des Ports.

Lettre du Directeur de l'Observatoire impérial de Paris à M. Airy, *Astronome Royal d'Angleterre.*

Mon cher Collègue, '4 Avril 1860.

Vous m'avez informé que Greenwich serait en mesure d'échanger télégraphiquement avec nous des dépêches météorologiques, et que sans doute cet avantage pourrait être étendu à d'autres points éloignés de la Grande-Bretagne et de l'Irlande. Votre communication nous arrive de la manière la plus opportune.

A diverses reprises, l'Empereur a voulu porter son attention sur les progrès auxquels son Observatoire impérial pourrait contribuer. L'utilité que devait avoir pour la Marine un système de communications météorologiques, transmises par les télégraphes, frappa dès l'abord Sa Majesté. Et, en conséquence, Elle daigna nous donner l'ordre de nous entendre à ce sujet avec l'Administration des Lignes Télégraphiques. Toutes les mesures dont j'ai à vous entretenir ont été

étudiées et mises à exécution avec le concours actif et éclairé de cette Administration.

Le plus grand obstacle qu'on doive rencontrer, provient de l'irrégularité des phénomènes atmosphériques qui mettent les navires en danger. Vous-même en jugeâtes ainsi lors d'une conversation que nous eûmes à Greenwich sur cette question. Je convins donc avec M. le Directeur des Lignes Télégraphiques, qu'avant tout nous organiserions en France un service régulier et administratif d'observations météorologiques, service dans lequel il serait facile de faire rentrer plus tard l'annonce des phénomènes susceptibles d'intéresser la Marine.

Vingt-quatre centres d'observations météorologiques, quotidiennes et régulières, ont été en conséquence établis en France par les soins de l'Observatoire impérial et de l'Administration des Lignes Télégraphiques ; ces établissements marchent depuis plusieurs années, et de la manière la plus satisfaisante.

Il fut entendu :

1°. Que l'Observatoire fournirait les instruments, pourvoirait aux dépenses des bulletins, des registres, &c. ;

2°. Que l'Administration des Lignes Télégraphiques ferait exécuter les observations dans ses postes, et que ce travail serait mis par elle au même rang que le service régulier et obligatoire des fonctionnaires ;

3°. Que les observations, transmises en partie par la voie télégraphique, seraient recueillies par l'Observatoire, mises en ordre, et publiées.

C'est ce programme qui a été rempli.

Douze des stations, savoir : Dunkerque, Mézières, Strasbourg, le Havre, Brest, Napoléon-Vendée, Limoges, Montauban, Bayonne, Avignon, Lyon, Besançon, expédient chaque matin leurs observations par voie télégraphique. Ces observations, discutées et réduites, sont, avec l'observation de Paris, insérées dans un Bulletin autographié, qui est envoyé le même jour aux divers Observatoires et aux Administrations qu'il intéresse, en France et à l'étranger. Les journaux qui le désirent en reçoivent communication.

Ce premier résultat étant obtenu, nous nous trouvâmes autorisés à nous addresser aux Observatoires de l'Europe, pour solliciter d'eux les communications nécessaires à l'extension de notre réseau. Toutes les Nations ont intérêt à se prévenir les unes les autres de l'apparition des tempêtes, et ce n'est que par un concert mutuel qu'on peut espérer d'arriver à des résultats sérieux et considérables.

Lors de la terrible tempête qui fondit sur la mer Noire en 1855, nous recueillîmes sur cette tourmente un grande nombre de données, au moyen desquelles nous parvînmes à établir qu'elle avait été produite par le transport d'une grande onde atmosphérique allant de l'ouest à l'est, et qui, un instant ralentie par les Alpes, mais augmentant toujours en intensité, avait mis plus de trois jours à traverser l'Europe, et enfin avait atteint la mer Noire. Nos flottes auraient donc pu être prévenues de l'arrivée de l'ouragan.

Au premier moment, on avait cru que la tourmente avait sévi partout à la fois : l'Angleterre, la France, l'Espagne étaient en effect soumises à son action en même temps que la mer Noire. Mais on reconnut bientôt que les deux tempêtes étaient distinctes l'une de l'autre, et avaient été successivement produites par le transport des ondes atmosphériques. Aussi, pendant que l'ouest et l'est de l'Europe étaient atteints, le centre (Vienne en particulier) jouissait d'un calme profond.

Notre appel fut partout entendu avec la plus grande faveur par les Observatoires et les Administrations télégraphiques étrangères, qui nous adressèrent les résultats obtenus dans leur propre pays, et vou-

lurent bien en outre consentir au passage gratuit des dépêches des pays plus éloignés.

L'Espagne et le Portugal nous envoient chaque jour les observations de Madrid, San-Fernando, et Lisbonne.

L'Italie nous donne Turin, Florence, Rome.

La Russe a mis la plus grande bienveillance à transmettre les dépêches adressées de Saint-Pétersbourg, et provenant de l'observatoire de cette ville, ainsi que de ceux de Varsovie, Revel, Riga, Moscou, et Nicolaïew.

Bruxelles, Copenhague, Stockholm, Haparanda prolongent notre réseau jusqu'aux latitudes les plus élevées.

Si Constantinople et Alger nous arrivent un peu moins régulièrement, on le doit à l'état des moyens de transmission. Cette partie du service s'améliorera très-prochainement.

Vienne enfin, nous n'en doutons pas, voudra bien reprendre ses communications que les circonstances ont malheureusement interrompues.

Tous ces documents sont, comme ceux émanés des stations françaises, régulièrement publiés chaque jour.

Telle était la situation, lorsque je reçus la lettre suivante de M. Rouland, Ministre de l'Instruction publique, dans les attributions duquel est placé l'Observatoire impérial :

" Je vous envoie copie d'une lettre écrite à M. le Ministre de l'Intérieur par la Chambre de Commerce du Havre, qui demande que la direction des vents régnant, à Brest et à Cherbourg soit signalée au Havre par la télégraphie nautique. En me transmettant cette lettre, M. le Ministre de la Marine donne son approbation à l'idée qui y est émise et dont il se montre disposé à rendre l'application générale.

" M. le Ministre rappelle à cette occasion qu'à une époque déjà ancienne il s'est entretenu avec vous de l'utilité que les marins pourraient retirer de la fréquente publication de bulletins météorologiques, transmis par la voie électrique, et faisant connaître l'état du temps sur certains points des côtes occidentales d'Europe. Cette mesure vous paraissait très-praticable.

" Avant de donner des ordres pour l'envoi des indications demandées par le commerce du Havre, M. le Ministre de la Marine désire savoir si vous seriez prêt à présenter un projet concernant l'établissement d'un service régulier de transmission de bulletins météorologiques entre les ports du littoral français.

" Je vous prie de me faire connaître, le plus prochainement possible, si une telle institution vous paraît réalisable et si vous seriez en mesure d'en préparer l'organisation."

Après m'être concerté avec M. Alexandre, Directeur des Lignes Télégraphiques, j'informai M. le Ministre de l'Instruction publique que nos postes météorologiques permettaient de réaliser facilement les intentions de M. le Ministre de la Marine : et, en conséquence, le 13 février, M. Rouland me fit connaître que M. l'amiral Hamelin avait désigné, pour représenter les intérêts de la Marine dans l'organization projetée, MM. de Montaignac et Roze, capitaines de vaisseau, Cloué, capitaine de frégate.

Procédant toujours pas à pas, afin de ne rien compromettre dans une matière si délicate, nous avons commencé par établir en France un service régulier qui fonctionne depuis le 1 avril. Pour atteindre ce but, il a suffi d'introduire quelques modifications dans notre organisation antérieure.

Chaque jour, nos ports joignent l'état de la mer, fourni par la Marine, à la dépêche qu'ils expédient le matin à Paris. Immédiatement, les divers ports reçoivent communication de l'état de l'atmo-

sphère et de la mer dans les parages qui leur importent. Ainsi, Cherbourg reçoit Dunkerque, le Havre et Brest. Brest à son tour reçoit Dunkerque, Cherbourg, Rochefort, Bayonne. Le port de Toulon est renseigné par Cette, Marseille, et Antibes. Vous trouverez plus loin le Tableau complet de ce service.

Dans l'après-midi, à trois heures, les ports informent de nouveau Paris de l'état de l'atmosphère et de la mer, mais en omettant le baromètre et le thermométre qui sont compris dans l'envoi du matin. Immédiatement, ces dépêches de trois heures sont addressées aux ports qu'elles intéressent.

Votre lettre, mon cher Collègue, nous fournit une occasion d'entreprendre dès a présent l'extension de ce service maritime. Les circonstances sont propices, s'il est vrai que Son Altesse le Prince Albert ait daigné récemment prendre en Angleterre la présidence d'une Commission chargée d'établir un service météorologique pour les côtes de la Grande-Bretagne et de l'Irlande.

Nous désirons vous addresser deux fois chaque jour, par voie télégraphique, les documents météorologiques qui sont à notre disposition et qui peuvent intéresser la sécurité de la Marine anglaise.

L'Amirauté peut dès à present choisir dans les stations suivantes : Dunkerque, le Havre, Cherbourg, Brest (Ouessant), Lorient, Rochefort, Bayonne, Montpellier (Cette), Toulon, et Antibes. Nous vous prions toutefois de ne réclamer que ce qui vous est strictement utile, afin de nous conserver plus de facilités pour vous transmettre ultérieurement les dépêches des nations étrangères et dont nous disposerons.

En retour, la Marine française désirerait avoir connaissance de l'état de l'atmosphère et de la mer à Scarborough (mer du Nord), à Portland et au cap Lezard (Manche), à Cork et à Galway (Irlande).

Nous adressons les mêmes propositions :

A l'Espagne, à qui nous demandons, par réciprocité, la Corogne, Cadix, Carthagène, Barcelone, et Mahon (Baléares) ;

A la Sardaigne, dont nous réclamons Gênes et Cagliari ;

A la Holland, en sollicitant d'elle le Texel.

Il peut se faire que, dans ces pays et en Angleterre, diverses circonstances exigent quelques modifications dans nos demandes, soit pour le choix des ports, soit pour les heures d'envoi. Nous acceptons à l'avance les changements qui seront jugés nécessaires, dans le but de hâter la mise à exécution.

Nos Correspondants des diverses parties de l'Europe, à qui je dois un compte rendu de cette nouvelle phase do nos opérations, jugeront sans doute que nous avons prudemment agi en commençant par organiser un service *régulier* pour les ports. Il ne nous appartenait, dans ce cas, de stipuler que pour les ports français. A chaque nation revient le droit d'examiner ce qui convient à sa marine.

Plusieurs états trouveront déjà de grandes facilités dans nos propositions. D'ailleurs, si nous n'avons pas de nouvelles demandes à présenter aux autres pays, à qui nous devons de nombreuses et importantes stations, le Portugal, l'Italie, l'Autriche, la Belgique, le Danemark, la Suède, la Prusse et la Russie nous trouveront prêts à faire droit aux requêtes qu'ils pourront nous addresser en vue de l'organisation de leur service maritime *régulier*. Ici encore il conviendra de se limiter aux données nécessaires, afin de ne point porter dans le service une complication qui nuirait plus tard aux dispositions à réaliser pour prévenir extraordinairement les côtes de l'approche des tempêtes.

Signaler un ouragan dès qu'il apparaîtra en un point de l'Europe, le suivre dans sa marche au moyen du télégraphe, et informer en temps

utile les côtes qu'il pourra visiter, tel devra être en effet le dernier résultat de l'organisation que nous poursuivons. Pour atteindre ce but, il sera nécessaire d'employer toutes les ressources du réseau européen, et de faire converger les informations vers un centre principal, d'où l'on puisse avertir les points menacés par la progression de la tempête.

Cette dernière partie de l'entreprise est aussi de beaucoup la plus délicate. Il faut éviter d'en compromettre le succès en voulant la produire avant le temps ou son utilité, universellement sentie, en fera partout réclamer l'organization. L'expérience du service maritime régulier donnera d'utiles enseignements à cet égard. Nous comptons d'ailleurs qu'à l'exemple du Directeur de l'Observatoire météorologique de Saint Pétersbourg, M. Kupfer, nos Correspondants voudront bien nous éclairer par leurs avis sur ces difficiles questions.

En attendant, il importe de maintenir avec soin notre système international de dépêches. Nous demandons aux Observatoires et aux Administrations télégraphiques de continuer avec le même zèle l'envoi et la transmission des documents : de notre côté, nous ne cesserons d'en assurer la publication avec la même ponctualité.

Recevez, mon cher Collègue, —

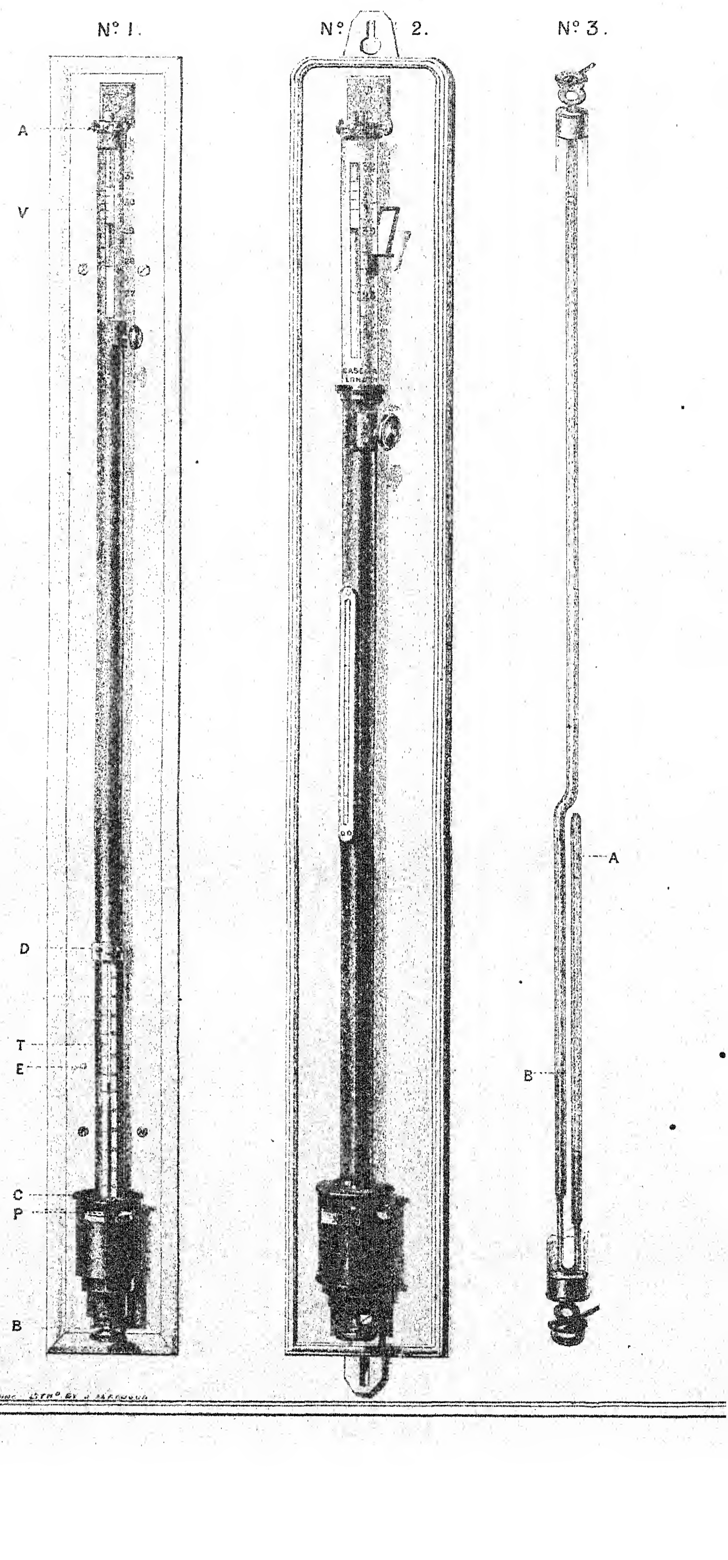
Le Directeur de l'Observatoire impérial de Paris,

U.-J. Le Verrier.

Service Météorologique des Côtes de France.

Dunkerque	reçoit	le Havre, Cherbourg, Brest.
Dieppe	„	Cherbourg, Dunkerque.
Le Havre	„	Dunkerque, Cherbourg, Brest.
Cherbourg	„	Dunkerque, le Havre, Brest.
Saint-Malo	„	Cherbourg, Brest.
Brest	„	Dunkerque, Cherbourg, Rochefort, Bayonne.
Lorient	„	Brest, Cherbourg, Rochefort, Bayonne.
Nantes	„	Brest, Rochefort, Bayonne.
Rochefort	„	Brest, Bayonne.
Bordeaux	„	Brest, Rochefort, Bayonne.
Bayonne	„	Brest, Rochefort.
Cette	„	Marseille.
Marseille	„	Cette, Antibes.
Toulon	„	Cette, Marseille, Antibes.

BAROMETERS.



DRAWN BY J. BOWRING. LITH? BY J. JEFFROUGH.

Section II.

DESCRIPTION OF THE INSTRUMENTS.

I. Barometer.

Observations on the Construction of Mercurial Barometers.

The modifications in the construction of mercurial barometers are almost endless, but in principle they are all alike. The simplest form is that of a syphon of glass, or a tube hermetically closed at one end, and about eight inches of it bent up like the letter **U**, about forty inches from the closed end. If such a tube be filled with mercury and then held in an upright position the mercury will be seen to descend from the closed end, leaving a perfect vacuum above it, of about four inches in length, called the *Torricellian vacuum,* and the column of mercury will be sustained at this height by the pressure of the atmosphere. The actual height of the column of mercury being measured by the interval between the surface of the mercury in the column and that in the portion of the tube turned up.

If a straight tube of glass about thirty-six inches long be hermetically sealed at one end, and when filled with mercury be made to stand in a cup of mercury, the mercury will descend in like manner, and the height of the column, which is sustained by and indicates the pressure of the atmosphere, will be measured by the interval between the surface of the mercury in the tube, and that in the cup.

In the application of the scales for the measurement of the height of the column of mercury, they are either fixed and graduated in reference to a zero or fiducial point, to which the surface of the mercury in the cup or cistern is adjusted, or the scale is made to move and the *zero point* brought to the surface of the mercury; or, again, as in the syphon barometers generally, the scale is fixed and the interval is read from two verniers on the scale, and the difference of the readings registered as the height of the column of mercury counterbalanced by the pressure of the atmosphere.

Barometers with closed cisterns, such as those excellent mountain barometers made by Newman, have no *zero point.* The scale is adjusted by reference to a standard barometer, and the relative capacity of the cistern and tube observed. Then, if the reading be *above* the point on the scale, called the *neutral point,* at which the scale was adjusted, and which is engraved on the instrument, the surface of the mercury in the cistern will be proportionally lower, and the proportional correction for its *capacity* (also engraved on the instrument) must be added to the reading to obtain the true height of the column, and if the reading be *below* the neutral point, the correction for capacity must be deducted.

The capillary action of the tube has the effect of depressing the mercury below the level at which it would stand in a wide, open vessel of any kind, and the effect is greatest in the smaller tubes; tables are, therefore, given for the *correction to be made for capillarity*, which is always additive.

To render all the readings strictly correct for the direct comparison with observations taken in any part of the world, we have to reduce the readings to what they would be at the uniform temperature of 32°, and tables are given for this correction. Then, if we make a correction for the altitude of the stations *above the level of the sea*, for which a very simple rule is given, we shall have brought the observations into a state for comparison with observations taken at any other station, that is to say, they will all be reduced to a common temperature and to a common level, and as all the barometers issued have been compared with the *one standard barometer* at Kew, the observations taken in any part of the world are strictly correct for comparison.

Barometers.

The barometer Figure No. 1, Plate I., has a cistern with an ivory point in it, which is the *zero of the scale;* the brass tube which surrounds the tube of mercury is the scale itself to which a vernier is attached, and by which the readings can be taken to the one-thousandth part of an inch; the instrument is secured by two brass collars to a mahogany board, and turns round freely with the hand, in the collars, in the upper one of which there are hree screws for adjusting the instrument in a perfectly vertical position.

Directions for putting up or taking down the Barometer Figure No. 1.

The barometer may be placed in any ordinary room, but care should be taken in selecting a position for it, that the sun cannot shine on it, nor should it be near a fire; at the same time it should be in a good light so that the point P and the vernier V can be well seen. If the bottom of the board to which the barometer is attached be placed at about two feet nine inches from the ground, the height will be found a convenient one for most observers. The instrument should be put up as nearly vertical as possible, and secured to the wall by means of the screws through the board. The screw at B is then to be turned back till the mercury in the cistern falls to the level of the point P; the ivory plug at C is then taken out with a pair of pliers, and for safety may be kept in the hole at E. The thermometer T is then inserted into the hole at C, and slipped over the heads of the screws at D, which serve to keep it in its place; the small piece of gutta percha round the thermometer should be pressed down so as to close the hole at C and keep out dust.

The perfectly vertical adjustment of the instrument is then made by means of the three screws at A; the point P is brought

into exact contact with the surface of the mercury, and as the instrument is turned round by the hand, if it be vertical, the point P will keep in exact contact with the mercury in every position; if not, it must be adjusted until it does do so.

In taking down the barometer, the thermometer is first taken off, and the ivory peg firmly screwed into the hole C; the screw B is then turned, and the mercury raised till it is within less than a quarter of an inch of the top of the tube, or till the screw is stopped by a piece of wire across it, which is placed there to regulate the height of the mercury; the instrument may then be taken down, and packed in an ordinary case, but it is better to carry it with the cistern upwards, and great care should be taken to prevent its receiving a fall or blow, or concussion of any kind.

The index errors of the barometers have been ascertained by a comparison with the standard barometer of the Observatory at Kew.

The index error of each, and the amount of capillary action, are recorded in a note pasted to the board on which the instrument is mounted, and should always be stated in the corner of the printed register.

Directions for reading the Barometer.

The level of the mercury in the cistern should be adjusted by the screw under it, so as exactly to touch the ivory point, which, with its reflection, will then appear as a double cone.

This point is the zero of the scale; the height of the column of mercury is then taken by adjusting the lower edge of the vernier, so that it shall be exactly tangent to the convex surface of the mercury in the tube, care being taken by gently raising and lowering the eye, to see that the eye be exactly in the same plane with the back and front lower edge of the vernier. The height should then be read.

Officers of engineers are so familiar with the reading of all kinds of instruments with verniers, that no directions are required for them in explanation of the mode of reading off the height, but, as many of the observers may not have been accustomed to instruments with verniers, the following directions may be found useful.

The brass tube, which surrounds the column of mercury, is the scale of the instrument, though only a small part of it, at the upper end is graduated; it is there divided into inches, tenths of inches, and half-tenths, or ·05. The vernier is graduated to ·002, and the observer can read to ·001, or the one-thousandth part of an inch.

For example, in reading such a number as 29·763, 29·750 will be read on the scale, and - - - - ·013

29·763

on the vernier; that is, the coincidence of the lines will not be exactly at ·012 or ·014, but would be intermediate between them.

A learner should set the bottom of the vernier exactly at 30 inches, then, slowly raising the vernier, mark the coincidence of the lines of the vernier and scale at 30·002, ·004, ·006, ·008, ·010, ·012 &c. to ·050, when he will see that the bottom of the vernier has also reached the ·05 on the scale, so that continuing to raise the vernier he commences to read again at the bottom of it, but adding the ·05, the readings become 30·052, ·054, ·056, ·058, ·060, ·062 &c. to ·098, ·100, ·102 &c. A very little practice will enable anybody to read off the instrument accurately and quickly; and it is important that the observations should be taken quickly, as the heat of the body, and of the hands is very rapidly communicated to the instrument and will affect the readings.

The reading of the attached thermometer should be taken at the same time the barometer is read.

It will be advisable to place two brackets against the wall near the barometer, so that a lamp or taper placed on them may enable the observer to adjust and read the instrument at night. A piece of white paper placed behind the tube of the barometer will improve the light for adjusting the instrument.

The height of the barometer and the attached thermometer having been correctly read and entered in the proper columns of the register, the corrections to be applied to the reading of the barometer should be immediately made, so as not to suffer the computations to run into arrear; they are exceedingly simple and require only a minute or two to make them.

In the example given on the register, the amount for index error and capillarity, being constant and stated on the instrument is put down at once, and the correction for temperature is taken out by mere inspection from Table II., page 14 of Appendix.

Example.

	Reading of barometer - -		29·756 in.; thermometer 77°
Correction	Index and Capillarity	+ ·023	
	Temperature - - -	− ·129	
			− ·106
	Corrected reading -		29·650

Figure No. 1 represents the form of the barometer first sent to the stations of the Royal Engineers.

Figure No. 2 is of nearly the same construction, but the thermometer is inserted into the tube of the barometer, instead of being placed in the cistern; a glass tube surrounds the graduated part of the scale and vernier, and it has a reflector sliding in the tube to facilitate the adjustment of the vernier to the exact height of the mercury.

The *Syphon Barometer of Gay-Lussac*, fig 3, Plate I., is perhaps the most elegant and perfect form of barometer which has ever been invented.

It consists of a glass tube bent in the manner represented in fig. 3, and so that the verniers on the two legs are in the same vertical line.

The end of the short leg is closed like the upper end, but, for the admission of air, the glass at A is pushed in, forming a small cone, punctured at the apex; and to prevent the ascent of any air into the upper end of the tube, an inverted cone of glass, like those in some ink bottles, is inserted at B.

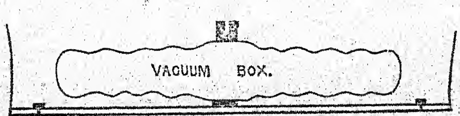
The tube is enclosed in a brass case, which is graduated as the scale of the instrument, the two verniers are read, and the difference gives the height of the column of mercury. A thermometer is attached to the case.

These instruments are generally used by travellers, &c., and for their carriage require only to be reversed.

The only drawback against the general use of these instruments, and it is a very serious one, is their great liability to being broken in carriage, but I hope to see them made of iron, enamelled inside and out, with strong glass ends as far as the ordinary range of the mercury.

A very concise and accurate table for the computation of altitudes from barometrical observations, without using logarithms, has been computed by Mr. J. O'Farrell, of the Ordnance Survey, and will be found in page 16 of Appendix.

The *Aneroid Barometer* has a vacuum formed by exhausting a flat copper box, the top and bottom of which is corrugated in concentric circles; by this simple and beautiful arrangement an elastic surface is formed, which is depressed or elevated in proportion to any increase or decrease in the pressure of the atmosphere.



The extent to which the surface can be depressed or elevated is very limited, but by the intervention of levers, and a fine chain round the pivot, which carries the index hand, its indications are so multiplied as to correspond with the indications of the mercurial barometers.

This is a most valuable instrument, it is extremely portable, and altitudes not exceeding 2,000 feet can be determined with it very approximately.

I have had one in use for upwards of ten years, and find it to be the best form of barometer, as a "weather glass," that has been made. It cannot, however, be depended on for the determination of altitudes in the same way that a mercurial barometer can be.

For if the vacuum in a mercurial barometer be maintained perfect, which is at once known by the sharp click the mercury gives

when the barometer is turned on one side, we may be certain that it will indicate the exact pressure of the atmosphere.

But the Aneroid Barometer is not an independent instrument; it requires to be adjusted to the indications of the mercurial barometer, as without this comparison we have no means of knowing that its indications are correct.

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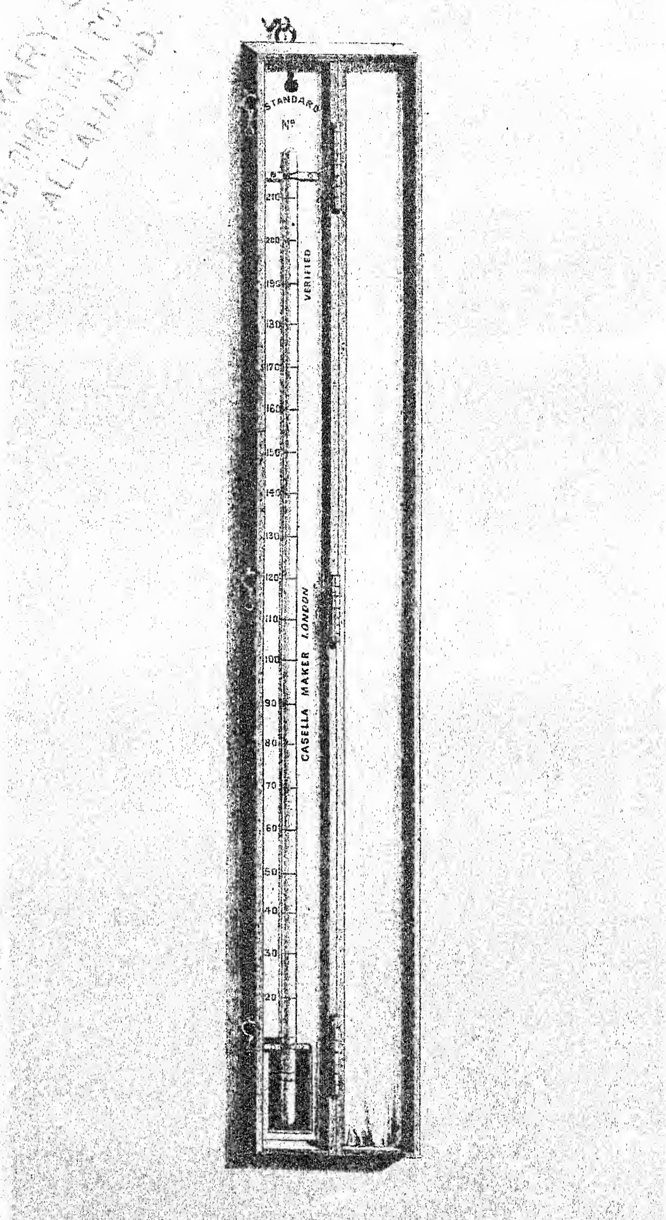
STANDARD THERMOMETER



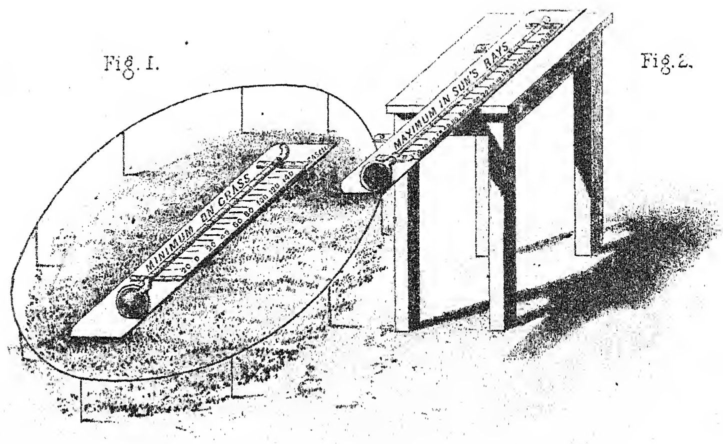
SCALE

0 1 2 3 4 5 6 INCHES

DRAWN BY J. DOWNING LITHO. BY J. FERGUSON

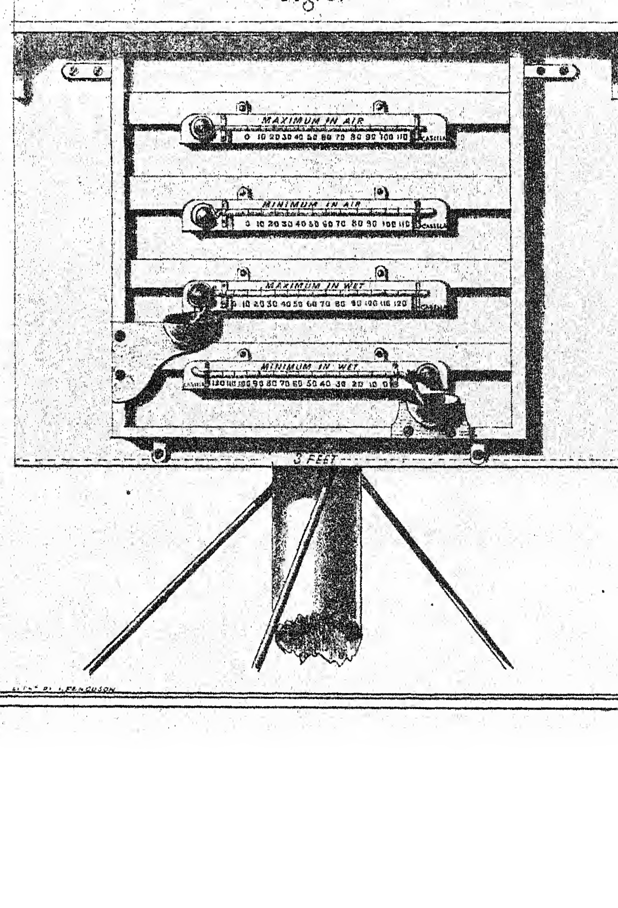
POSITIONS OF MAXIMUM & MINIMUM THERMOMETERS.

Fig. 1. Fig. 2.



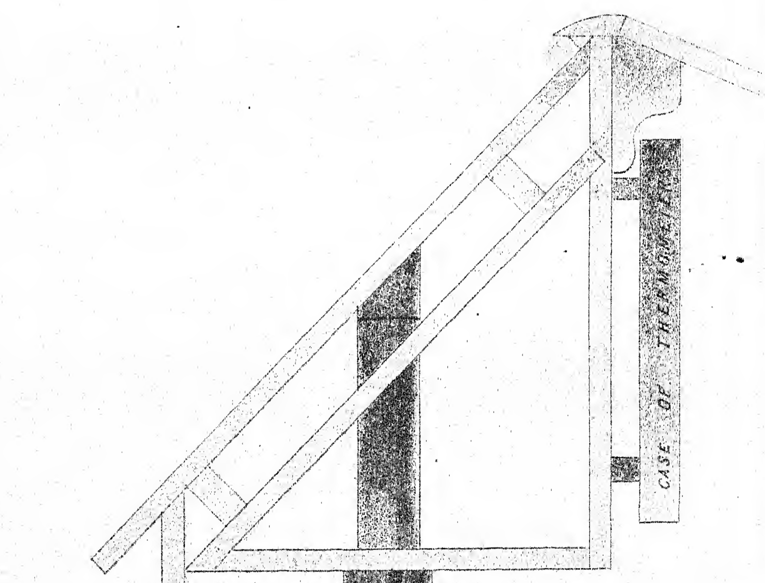
FRONT VIEW OF THERMOMETER STAND

Fig. 3.



DRAWN BY J. BOWNING. LITH. BY [illegible] FERGUSON

END VIEW OF THERMOMETER STAND.



2. Thermometers.

A complete set of thermometers includes,—

1 Standard.
1 Maximum in air (dry bulb).
1 Minimum in air (dry bulb).
1 Maximum (wet bulb).
1 Minimum (wet bulb).
1 Maximum in the sun, with blackened bulb.
1 Minimum on the grass, plain bulb.

And these should be all compared with the Standard Thermometer at the Royal Observatory at Kew, and a certificate of the amount of the index-error, if any, given with them.

The ranges of the thermometers should be such as to meet the extreme range of temperature of the stations. In the Arctic regions the temperature falls below the freezing point of mercury, that is, below $-39°$,* whilst in the Tropics it may not fall below $+70°$.

The *Standard* Thermometer, Plate II., should be kept for the occasional comparison of the others, and should be graduated on a scale sufficiently open to read to a small fraction of a degree.

The four thermometers, maximum dry, maximum wet, minimum dry, and minimum wet, should be arranged as in the case represented in fig. 3, Plate III.

The wet bulbs being supplied with moisture from the two hemispherical copper cups screwed on to the case, as shown on the drawing. When ice is formed in these hemispherical cups, it has free room to expand, without the risk of bursting the cups.

This Case of thermometers is attached to a stand, of the construction shown in Plate IV.

The stand is double at the back, and revolves on a post at about four feet from the ground; the Case of thermometers is kept out by blocks about two inches from the face of the stand, to allow the air to circulate freely round the thermometers.

The Maximum Thermometers which are most approved of, and least liable to get out of order, are those invented by Professor John Phillips, and made by Casella. In these thermometers the thread of mercury is simply broken, and the detached portion being pushed forward by any increase of temperature is left there, indicating the maximum temperature of the air or of evaporation during the period between which the observations are registered.

The thread of mercury in these thermometers is easily broken at any point required, by simply raising the bulb end, and allowing the mercury to run into the open cell at the end, and, as it descends, detaching, with a slight jerk, as much of it as may be thought necessary, which should be an inch or an inch and a half.

The Minimum Thermometers are filled with spirit of wine, and have a double-headed index in their tubes, like miniature "life preservers" or "dumb bells."

* Sir Leopold McClintock registered $-48°$, or $= 9°$ below the freezing point of mercury.

As the temperature decreases, the spirit draws back the index with it, whilst on an increase of temperature the spirit flows round the index, without disturbing its position; the upper end of the index, therefore, shows the minimum temperature of the air, or evaporation, between the periods at which the observations are registered.

After the observations are registered, the detached portion of mercury in the maximum thermometers, should be all but re-united with the thread from the bulb; this is done by simply turning up the thermometer, and gently tapping it.

In like manner, the index in the minimum thermometers should be allowed to slide down to the end of the thread of spirit. If in transit the index should be shaken out of the spirit, or the thread of spirit broken, the instrument can be put in order by holding it with the bulb down, and giving it a sharp swing, to send the index into the spirit, and to close the spaces in the thread of spirit; after this is done, the instrument should be suspended with the bulb downwards for half an hour, and it will then be in perfect order for use.

The blackened bulb of the maximum thermometer in the sun should be placed on a stand, at about two feet from the ground, but not near a wall, where it would receive the reflected as well as direct heat of the sun, fig. 2, Plate III.

The bulb of the minimum thermometer on the grass should be placed on the grass, or on wool or hair, and protected by some guard from accident, fig. 1, Plate III.

All these thermometers are attached to metal and enamelled scales, which, from experience, we have found the best for withstanding the effects of weather.

Directions for determining the Index-Errors of Thermometers.

Take some pounded ice in a basin, and place the standard and the thermometer under examination in it, then pour in a little cold water, and note the readings of the two thermometers as they descend to 32°; then pour in cold water, and note the readings of the thermometers as the temperature gradually rises.

Next, holding the two thermometers together, place them in a basin or jug of cold water, and gradually pour in hot water, stirring the water with the thermometers all the while, that the heat may be equally diffused, and note the readings of the two thermometers as the temperature is gradually raised to the limits of the scales.

In this way two columns of readings will be obtained from the freezing to near the boiling point, which should be entered in a table with four columns; the first for the readings of the standard, the second for the readings of the standards corrected for their *index-errors*, the third column for the readings of the thermometer under examination, and the fourth for the differences, plus or minus, between the corrected readings of the standard and the readings of the thermometer under examination.

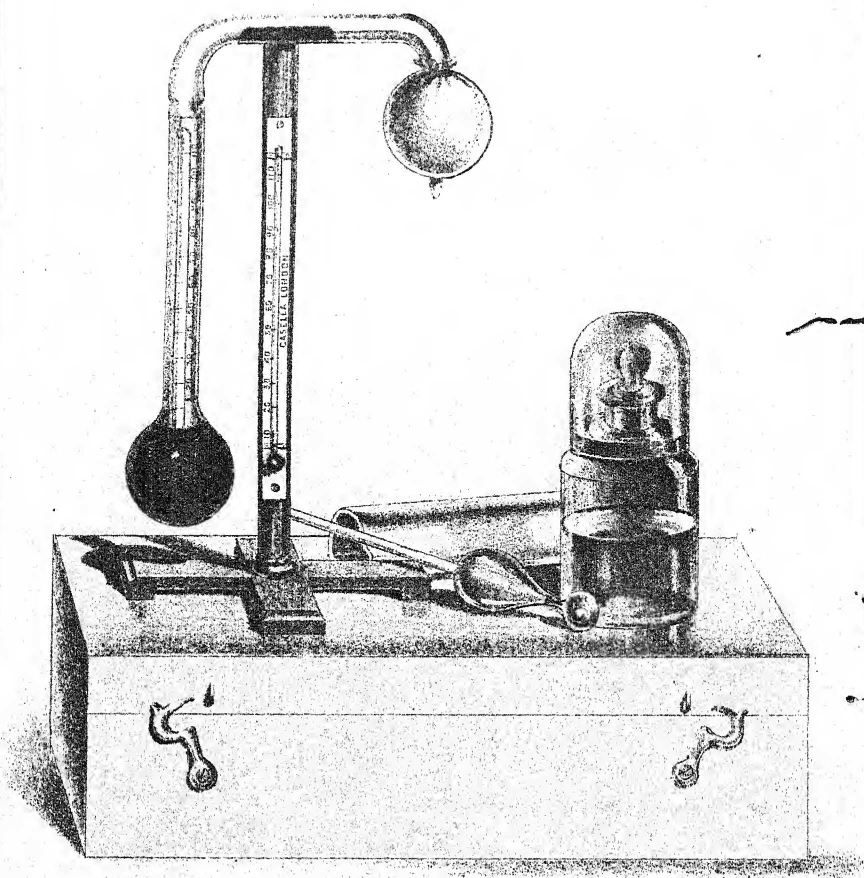
These differences, or *index-errors*, can then be grouped, as thus,—

From 32° to 41°	*index-error*	—	·5
45 to 60	„	+	·25
61 to 100	„	+	·75

and entered in the corner of each monthly register sheet.

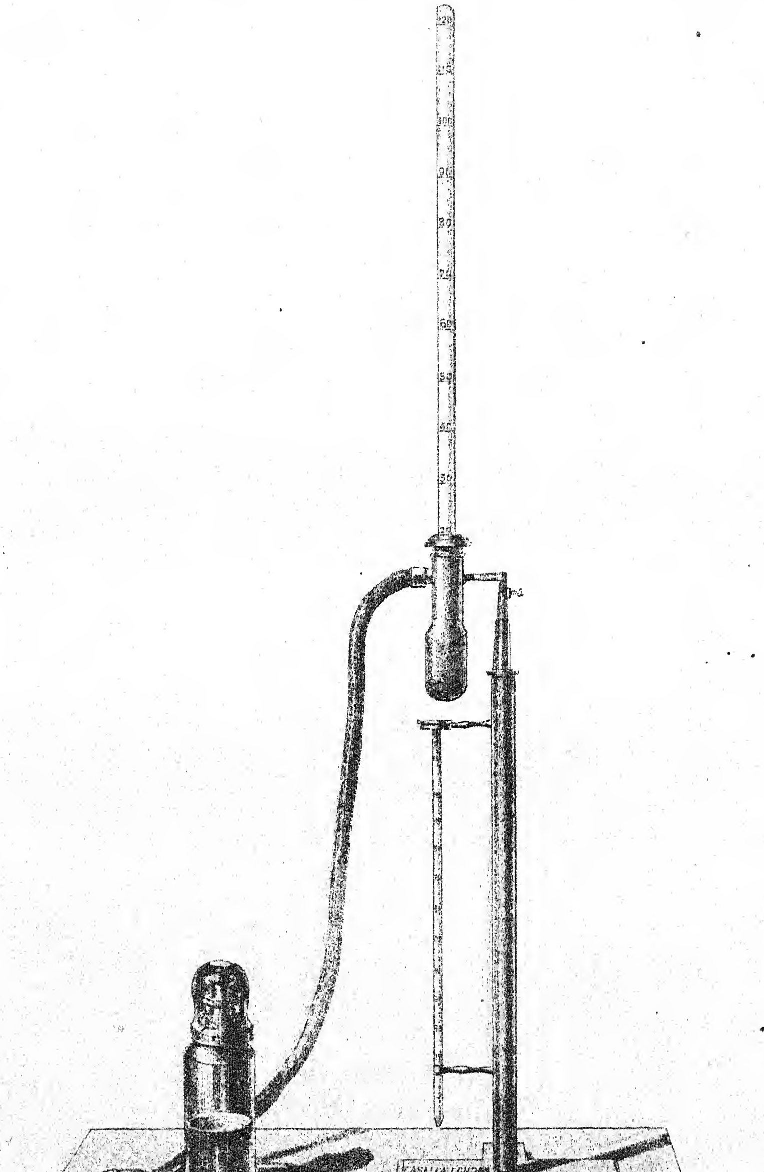
In applying the above differences to the readings of the thermometer, as correction for *index-errors*, the *contrary signs* will be used.

DANIELL'S HYGROMETER



DRAWN BY J. DOWNING   LITHD BY J. FERGUSON

REGNAULT'S IMPROVED HYGROMETER.



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SCALE.

0 6 12 INCHES.

3. Hygrometers.

The degree of humidity, and the amount of aqueous vapour in the air, at any moment, may be ascertained either from observations of the temperature of the dew-point with Daniell's or Regnault's hygrometers, or from observations of a dry and wet bulb hygrometer.

Daniell's hygrometer consists of two glass bulbs, connected with a tube, and bent into the form shown in Plate V. It is partly filled with Ether, and has a small thermometer in one arm, the bulb of which is blackened, whilst the other bulb is covered with fine muslin, or tissue paper. A second thermometer, to indicate the temperature of the air at the moment of observation, is attached to the stand on which the instrument is mounted. To ascertain the temperature of the "dew-point," that is, the temperature to which the air must be reduced to produce the precipitation of its contained vapour, the ether is first made to flow into the blackened bulb, and then the covered bulb is moistened with ether, which is allowed to drop from a bottle in the hand of the observer.

The rapid evaporation of the ether quickly reduces the temperature of the ether within the blackened bulb, and the vapour of the external air is precipitated upon it. The temperature of the enclosed ether, at the moment when the vapour first appears as a ring round the blackened bulb, or at the moment before its first disappearance, is to be noted from the indications of the enclosed thermometer, and this, with a note of the indications of the external thermometer, completes the observations.

Tables of the "elastic force or tension of vapour," are given in the Appendix No. IV. p. 18, from which the humidity of the air is obtained by dividing the elastic force of vapour at the temperature of the dew-point by the elastic force of vapour at the temperature of the air.

For example, let the observed temperature of the dew point be 50°, and that of the air be 70°, to find the degree of humidity:—

Elastic force corresponding to 55° in Table IV. = ·433
" " " 70° in do. = ·733

$$\text{Hence, degree of humidity} = \frac{\cdot 433}{\cdot 733} = 0 \cdot 590$$

the *maximum* saturation of air at any temperature by vapour being represented by 1·000.

Regnault's Hygrometer is in principle precisely the same as Daniell's. A thermometer is inserted into a cup made of silver, into which ether is poured. See Plate VI. The temperature of the ether is lowered by passing a current of air through it, either by means of a bellows or by blowing through a tube of gutta percha from the mouth.

The moisture of the air is precipitated on the external surface of the cup, and the temperature of the dew-point and of the air noted.

In extremely dry climates, such as that of the Deccan in India, it is almost impossible to obtain the temperature of the dew-point

by means of Daniell's hygrometer; and for such localities Regnault's is much preferable, as by its means the temperature can be lowered to such a degree as to freeze water very quickly in the hottest day.

Dry and Wet Bulb Hygrometers.—These consist of two thermometers, the bulb of one of which is covered with fine muslin or tissue paper, and supplied with moisture, either by capillary action through a skein of thread from a vessel of water, or by simply dipping the bulb in water and shaking off the drop, which would otherwise hang from it. The temperature of the air and the temperature of evaporation are then to be noted.

Dr. Apjohn has given the following formulæ for obtaining the temperature of the dew-point, from the indication of the dry and wet thermometers.

$$\text{Formula No. 1}\ldots f'' = f' - {\cdot}0114 \times d \times \frac{p - f'}{30}$$

when the temperature of evaporation is above 32°, in which f'' = the tension of vapour at the temperature of the dew-point; f' = the tension of vapour at the temperature of evaporation; d = the difference between the readings of the dry and wet thermometers; and p = the height of the barometer.

Example.

Temp. of air =	63°·5	Barometer .... p =	Inches. 30·47
Do. of evap. =	57·3	corres. ten. of vapour f' =	·47......f' = ·47054 from Tab. IV.
Difference =	6·2	$p - f'$ =	30·00

Hence, $f' - f'' = {\cdot}0114 \times 6{\cdot}2 \times \frac{30}{30} \ldots = {\cdot}07068$

Resulting temp. of Dew-point = 52°·8, corresponding to f'' = ·39986 in Tab. IV.

$$\text{Formula No. 2}\ldots f'' = f' - {\cdot}01017 \times d \times \frac{p - f'}{30}$$

when the temperature of evaporation is below 32°.

Mr. Glaisher, who has charge of the meteorological observations taken at Greenwich, under the direction of the Astronomer Royal, has published a table of "factors," by which the temperature of the dew-point can be obtained approximately, by deducting the product of the difference between the indications of the dry and wet thermometers, and the factor from the temperature of the air.

$$D - (D - W) \times f = \text{temperature of the dew-point.}$$

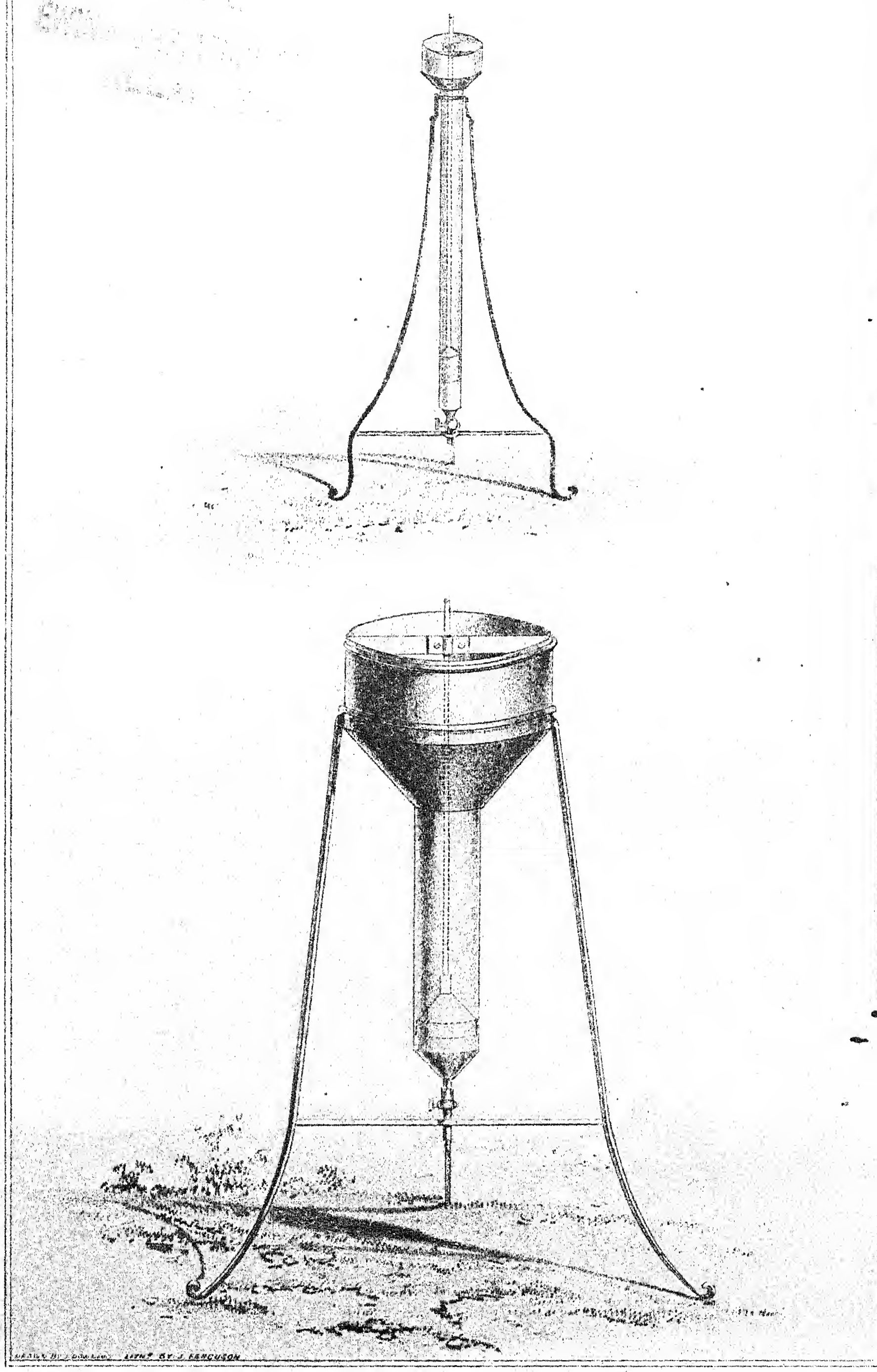
Example.

Dry bulb - - -	= 63°·5	
Wet ditto - - -	= 57·3	
Difference - - -	= 6·2	
Factor - - -	= 1·9...	Table V. Appendix, p. 28.
	558	
	62	
	11·78	
Temperature of dew-point	= 51·72	

This, it will be observed, is 1°·1 below the temperature of the dew-point as derived from Apjohn's formula. Apjohn's formula should always be employed.

The thermometers in the case represented in Plate III., fig. 3, form two dry and wet bulb hygrometers; Nos. 1 and 3 mercurial, and Nos. 2 and 4 spirit. The hygrometric observations should *be taken from the spirit thermometers.*

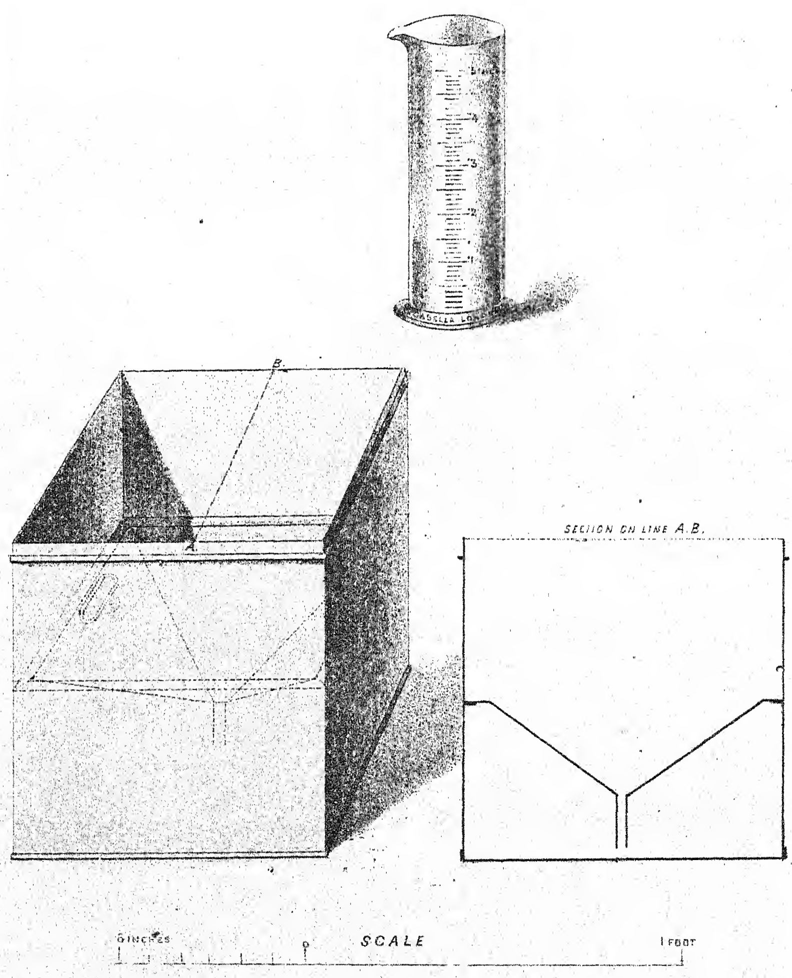
RAIN GAUGES.



SCALE.

12 INCHES 0 1 2 FEET

SQUARE RAIN GAUGE AND GLASS MEASURE.



DRAWN BY J. DOWNING

4. Pluviometer, or Rain Gauge.

The rain gauge, figured in Plate VII., is found to be of a very convenient construction, and is well suited for all countries excepting those in which there are frequent hard frosts.

It consists of a cylindrical receiver connected with a small receiver, the sectional areas of which are in the ratio of 10 to 1.

Some water is always allowed to remain in the gauge to float the air-tight box which carries the graduated rod or index and to afford the means of adjusting the index to its zero.

The zero of the scale is at the level of the bar across the mouth of the receiver, and the rod is graduated to inches and tenths of an inch.

It is obvious that by this arrangement, if rain to the depth of $\frac{1}{100}$ part of an inch falls, the index will rise $\frac{1}{10}$ of an inch, and that if $\frac{1}{10}$ falls, the index will rise one inch, and so on.

The gauge may be made either of zinc or copper, and may be supported on a stand, as in the drawing, or let into a hole in the ground with its mouth at the level of the surface.

The objection to this form of gauge is, that the water in the receiver, when frozen, is apt to burst it.

The rain gauge, figured in Plate VIII., consists of an open cubic box made of zinc or copper, the sides of the cube being 10 inches; and, therefore, if an inch of rain falls, the quantity in the receiver will be 100 cubic inches, and 50 cubic inches will indicate a fall of half an inch.

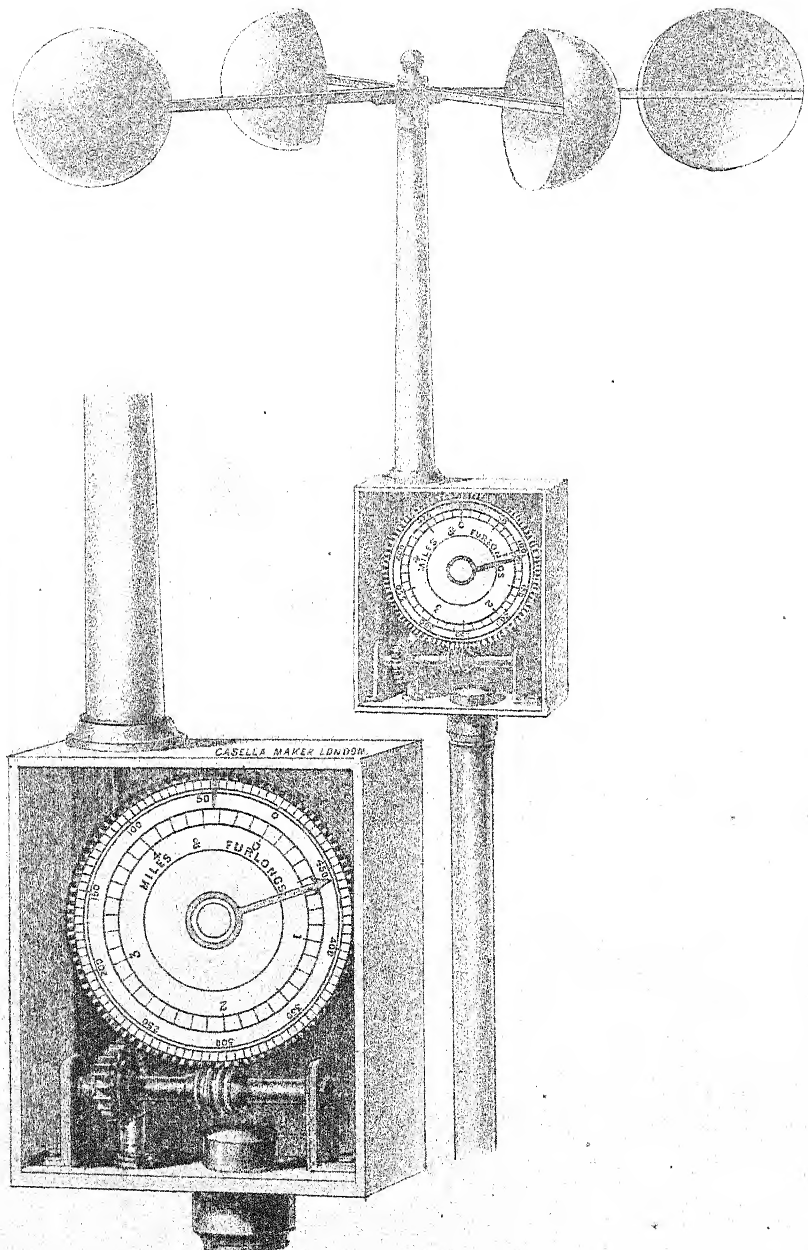
The amount of rain which falls is poured into a cylindrical glass measure, which has been graduated by pouring into it 50 cubic inches (equal to 28·935 ozs. at the temperature of 60°), and dividing the height to which the water rises into equal parts, from one-tenth to five-tenths of an inch; these divisions are again subdivided into tenths, each corresponding to $\frac{1}{100}$ of an inch of rain-fall.

Anyone can, therefore, easily make a graduated measure by attaching a scale to any sort of glass tube which he may be able to procure.

The moveable divisional plate in the receiver is for the purpose of preventing evaporation.

IMPROVED ANEMOMETER.

FOR REGISTERING THE VELOCITY OF THE WIND IN MILES AND FURLONGS.



N.B. The small Drawing is one fourth the size of the Instrument.

DRAWN BY [illegible] DOWNING

LITHO. BY J. FERGUSON

5. Wind Gauge.

There are several kinds of wind gauges, each of which possesses advantages depending upon the nature and extent of the observations to be registered.

Thus, for example, for a permanent observatory, in which the direction, velocity, or pressure of the wind is to be constantly registered, Osler's or Whewell's self-registering anemometers are the best; whilst as a convenient portable instrument, Lind's anemometer (as modified by Sir W. Snow Harris) is well suited for observing the pressure of the wind at any particular moment.

But the anemometer designed by Dr. Robinson, of Armagh, (as made by Casella,) appears to be best suited for general use; it is simple in its construction and not liable to get out of order, whilst it registers the velocity of the wind at any moment, or the current of air passing the station during the hours between the periods of observation.

A drawing of this instrument is given in Plate IX. It consists of arms, at the end of which there are four light hemispherical hollow cups, which, as Dr. Robinson has demonstrated, revolve with one-third of the velocity of the current of wind acting on them. On the vertical axis which carries the arms there is an endless screw, which communicates its velocity of rotation to a circular index.

This index has two graduated circles, the outer one of which is graduated for five miles, from 0 to 500, and the inner into five miles, each mile divided into furlongs.* The moveable hand, from the centre, indicates the number of miles of air in the current which has passed the station, as 5, 10, 15, whilst the fixed hand indicates the number of odd miles and furlongs, as 3 miles 5 furlongs, at which the moveable hand stands beyond the five-mile graduation. If, for example, the moveable hand stands between 15 and 20 on the outer circle, and the fixed hand indicates 3 miles 5 furlongs, the length of the current has been 18 miles 5 furlongs.

The velocity of the wind at any particular moment is found by observing the index before and after a certain interval of time, as one or five minutes, and then multiplying the rate by 60 or 12 to find the velocity in miles per hour.

The pressure in lbs. per square foot can then be ascertained by reference to Table VIII. p. 32 of Appendix. A milled-headed screw, at the back of the instrument, turns the moveable index, which should be brought back to zero after the observation is registered.

A socket under the instrument is furnished for screwing on the instrument to a post of any kind, a piece of iron gas-pipe is, perhaps, the best support for it.

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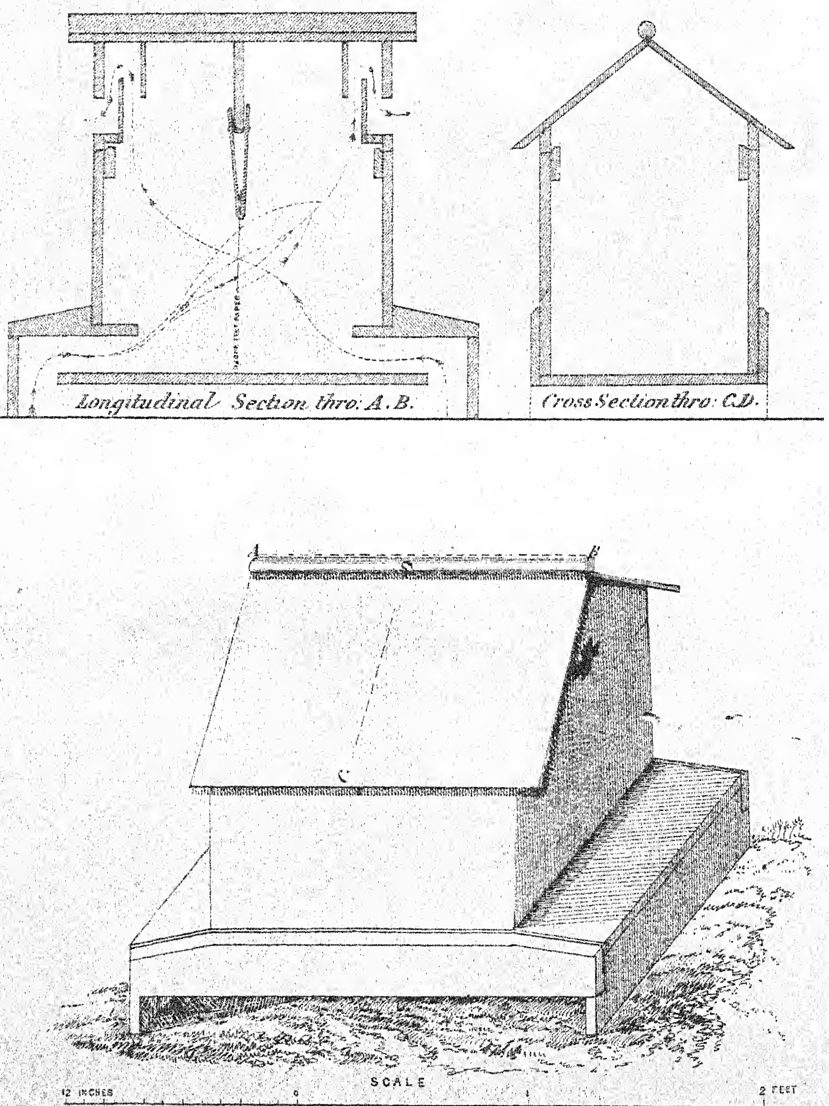
* It would be better if the mile were divided into tenths, instead of eighths.

PLAN AND SECTIONS OF BOX FOR EXPOSING OZONE TEST PAPERS (DR MOFFATT'S) TO THE CURRENTS OF AIR WITHOUT THE ADMISSION OF LIGHT



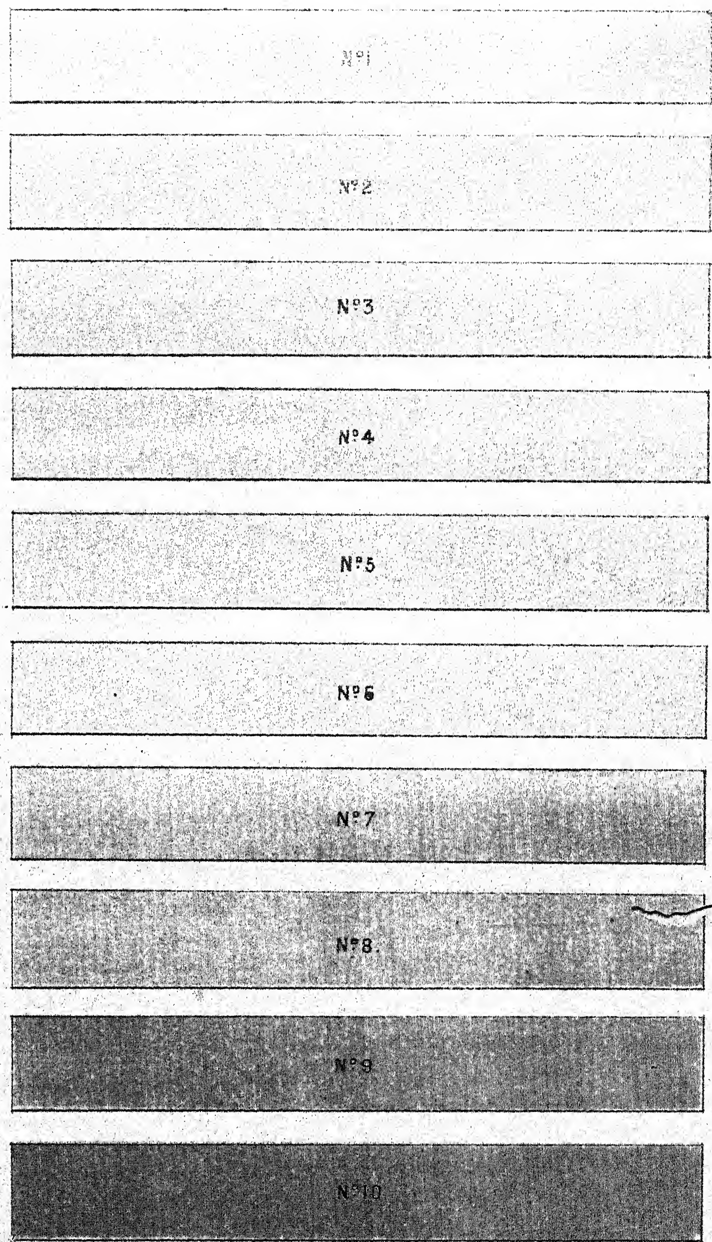
Longitudinal Section thro: A.B.

Cross Section thro: C.D.

DRAWN BY J. DOWNING.

OZONE SCALE.

Arranged for Dr Moffatt's Ozone test papers.



DRAWN BY J. [illegible] LITHD BY J. FERGUSON.

6. Ozonometer.

Faraday defines ozone as oxygen in an altered or allotropic condition.

Dr. Andrews, Professor of Chemistry in Queen's College, Belfast, says, "There can be doubt of the formation of ozone "from pure and dry oxygen, by the action of the electrical spark, "and nothing is easier than to convert the whole of a given "volume of oxygen into ozone in presence of a solution of iodide "of potassium."

"Ozone is converted by heat into ordinary oxygen, and would "at the common temperature of the air, if preserved in an "hermetically sealed glass tube, gradually change into common "oxygen."

Dr. Moffat's ozonometer consists of slips of paper prepared with iodide of potassium and starch,

These papers are suspended so as to be exposed to the free access of air, but not to the direct rays of the sun.

The box represented in Plate X. is designed to hold the papers, it is painted black inside.

These papers, when affected by ozone, are found tinged with various shades of brown, of which the intensity is measured by a scale of ten gradations. See Plate XI.

The brown tinge of the ozonometer is produced by the decomposition of the iodide of potassium; the oxygen of the ozone combining with the potassium, and setting free the iodide, which now forms the iodide of starch.

These papers may be obtained from Casella, 23, Hatton Garden, London.

Dr. Moffat observes, that a current of air passing over a locality charged with the products of decomposition will be that of the minimum of ozone; and another proceeding from a locality in which these products are not in sufficient quantity to take up the ozonized air, will be that of the maximum of ozone; and that in places where the air is stagnant, and during calms, ozone will be at its minimum.

It has been observed, that in England ozone is more generally present in the atmosphere during the prevalence of the southerly winds than during the prevalence of the northerly winds; and that the presence of ozone is indicative of a pure atmosphere, and its absence, of an impure and unhealthy atmosphere. It is desirable, therefore, that a note should be taken at least once a day of the indications of the ozonometer papers, and entered in the Meteorological Register.

7. Forms of Clouds.

The simple modifications of clouds are thus named and defined by Howard, *see* "Essay on the Modifications of Clouds," by that author.

1. *Cirrus.*—Parallel, flexuous, or diverging fibres, extensible by increase in any or in all directions.
2. *Cumulus.*—Convex or conical heaps, increasing upward from a horizontal base.
3. *Stratus.*—A widely-extended continuous horizontal sheet, increasing from below upward.

The intermediate modifications which require to be noticed are,—

4. *Cirro-cumulus.*—Small well-defined roundish masses, in close horizontal arrangement or contact.
5. *Cirro-stratus.*—Horizontal or slightly-inclined masses, attenuated towards a part or the whole of their circumferences, bent downward or undulated, separate or in groups, consisting of small clouds having these characters.

The compound modifications are,—

6. *Cumulo-stratus.*—The cirro-stratus blended with the cumulus, and either appearing intermixed with the heaps of the latter, or superadding a wide-spread structure to its base.
7. *Cumulo-cirro stratus,* vel *nimbus.*—The rain cloud. A cloud, or system of clouds, from which rain is falling. It is a horizontal sheet, above which the cirrus spreads, while the cumulus enters it laterally and from beneath.

Kaemtz, adopting the definitions of Howard, has described the appearances of the clouds in more familiar terms, thus:—

"The *cirrus* (the *cat's tail* of sailors) is composed of thin filaments, the association of which sometimes resembles a brush, at other times woolly hair, and at times slender net-work.

"The *cumulus,* or summer-cloud (*ball of cotton* of sailors), frequently presents itself in the form of a hemisphere resting on a horizontal base. Sometimes these hemispheres are built one upon the other, and form those great clouds which accumulate on the horizon, and resemble at a distance mountains covered with snow.

"The *stratus* is a horizontal band, which forms at sunset and disappears at sunrise. Under the name of *cirro-cumulus,* Howard designates those little rounded clouds which are often called woolly clouds; when the sky is covered with them it is said to be *fleecy.*

"The *cirro-stratus* is composed of little bands of filaments more compacted than those of the cirrus, for the sun has sometimes a difficulty to pierce them with his rays. These clouds form horizontal strata, which at the zenith seem composed of a great number of thin clouds, whilst at the horizon, when we see the vertical projection, a long and very narrow band is visible.

"When the *cumulus* clouds are heaped together and become more dense, this species of cloud passes into the condition of *cumulo-*

stratus, which often assumes at the horizon a black or bluish tint, and pass into the state of *nimbus* or rain cloud. The latter is distinguished by its uniform grey tint and its fringed edges; the clouds of which it is composed are so compounded that it is impossible to distinguish them."—*See Frontispiece.* Plate XII.

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8. Periods of Observation.

Daily observations are to be taken regularly at $9\frac{1}{2}$ A.M. and $3\frac{1}{2}$ P.M.

The indications of the self-registering instruments are also to be taken at $9\frac{1}{2}$ A.M.

As these hours fall within the regular working hours of the officers and of those who are employed in the offices, all of whom may be instructed accurately to read and register the instruments, it is expected that the observations at these hours will be made with great care and regularity; but it is hoped that many of the observers will take an interest in meteorological science, and make arrangements to have observations also taken at $9\frac{1}{2}$ P.M. and $3\frac{1}{2}$ A.M. as often as possible. These observations to be inserted in a separate register, writing the word "Night" in the right-hand upper corner, and using columns 1 to 13 for the $9\frac{1}{2}$ P.M., and columns 25 to 37 for the $3\frac{1}{2}$ A.M. observations.

Hourly observations are to be taken on the 21st March, 21st June, 21st September, and 21st December, commencing at 6 A.M. on those days, unless they fall on a Sunday, in which case the observations will commence at 6 A.M. on the 22nd.

The same form of register will answer for the hourly observations, using 24 of the lines for the days of the month for the hours of the day.

It would add greatly to the value of the observations of the station if the hourly observations are taken more frequently, and it is recommended to those who are desirous to furnish more exact information (and it is hoped there are many who will do so), to take hourly observations on the 21st of each month.

Occasional observations should be taken hourly, or even more frequently, when any sudden great *rise* or *fall* in the barometer should seem to indicate great atmospheric changes, as well as during periods of *hurricanes* or very severe *gales* of wind, or earthquakes.

Occasional remarks on the character of the weather, from personal sensation, should be inserted in the column of "Remarks;" they will assist, in conjunction with the registered observations of the instruments, in determining the atmospheric conditions which are most favourable, or otherwise, to health.

The remarks should be simply, "agreeable," "very agreeable," or "delightful" weather, or "disagreeable," "very disagreeable," or "most disagreeable" weather.

The original registers and diagrams are to be transmitted monthly, or as soon as opportunities occur after the expiration of each month, to the *Inspector-General of Fortifications*, and authentic copies of the registers are to be kept at the station.

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9. Form of Register and Diagram.

A form of Register and Diagram has been filled in from the Southampton Observations for September 1859 as an example, and will be found in the Appendix.

Directions for filling in the Diagram.

Barometer.—The heights from the corrected reading of the 9.30 A.M. daily observations should be plotted on the strong lines for the days of the month, and the 3.30 P.M., 9.30 P.M., and 3.30 A.M. observations on the intermediate lines between those for the days of the month, and the whole space below this, coloured with a light wash of indigo, and a dotted line drawn across the diagram at the mean height.

Pressure of Wind.—The readings should be plotted in the same manner, and a shade of grey put over the space.

Rain.—The quantities should be shown by dark vertical lines $\frac{1}{12}$th of an inch wide, to represent the depths.

Maximum Temperature.—Should be plotted like the barometer heights, and the tint of indigo washed over all the lower part of the diagram.

Minimum Temperature.—To be plotted in the same way, and a second darker shade of indigo washed over.

Mean Temperature.—Draw a dotted line between the maximum and minimum for the mean temperature of the days, and a firm line straight across the diagram for the mean temperature of the month.

Humidity.—To be plotted and shaded like the pressure of the wind. *See* Example in Appendix.

Ozone.—The amount to be plotted above the barometer and coloured. *See* Example in Appendix.

The diagrams thus filled in will exhibit at a glance any peculiar atmospheric phenomena, and by comparing the diagrams from the different stations the peculiar character of the climates will be seen, and probably the extent of great atmospheric disturbances.

The connexion, also, between the height of the barometer, the force and direction of the wind, the quantity of rain, the temperature, and the humidity of the air can be traced by mere inspection.

Section III.

NOTES ON METEOROLOGICAL SUBJECTS.

1. Circulation of the Atmosphere.

The general course of the winds in circulating from the poles to the equator will be readily understood by a reference to the diagram, Plate XIII., which is taken from Captain Maury's* Sailing Directions, p. 18.

Along the equator we have a belt of calms of several degrees in width, in which the air heated and expanded under a vertical sun, becomes specifically lighter, and ascends into the higher regions of the atmosphere, and then, overflowing north and south, passes over the "trade winds," which flow in from either hemisphere, and descending towards the surface of the earth, in latitude about 30°, then crossing the winds coming from the poles, in what are called the "horse latitudes," proceeds, converging towards the poles as a surface wind, where it again ascends, and proceeding towards the equator, descends through the calm of Cancer and Capricorn, and as a surface wind forms the "trade winds" before referred to.

If we could suppose the earth at rest, the course of the winds would be due north and south in its circulation; but, in consequence of the eastward rotation of the earth, the winds coming from the poles towards the equator are met with the earth's higher velocity in the equatorial regions, and become north-east or south-east winds.

This may be considered as the normal course of the winds, and this is the course which they follow over large areas of the great seas, where no disturbing influences exist; but on the continents,

* U.S. Astronomer at Washington.

especially in tropical regions and in the seas adjacent to them, this normal course is frequently changed to such an extent that no trace of it remains, the winds, in such situations, deriving their course from the ascending columns of air over the heated surfaces of the continents, and drawing in the air from all quarters to supply the loss thus caused; and, as the most intensely heated surfaces must be in those parts over which the sun is vertical, the locality of the centres of the ascending columns must librate with the seasons, and hence it is that we have those great periodic changes in the wind which are called the monsoons. So great is the effect of the landward draft of the wind, from the Atlantic towards the centre of Africa, that its influence has been felt near the equator almost as far across as the coast of South America.

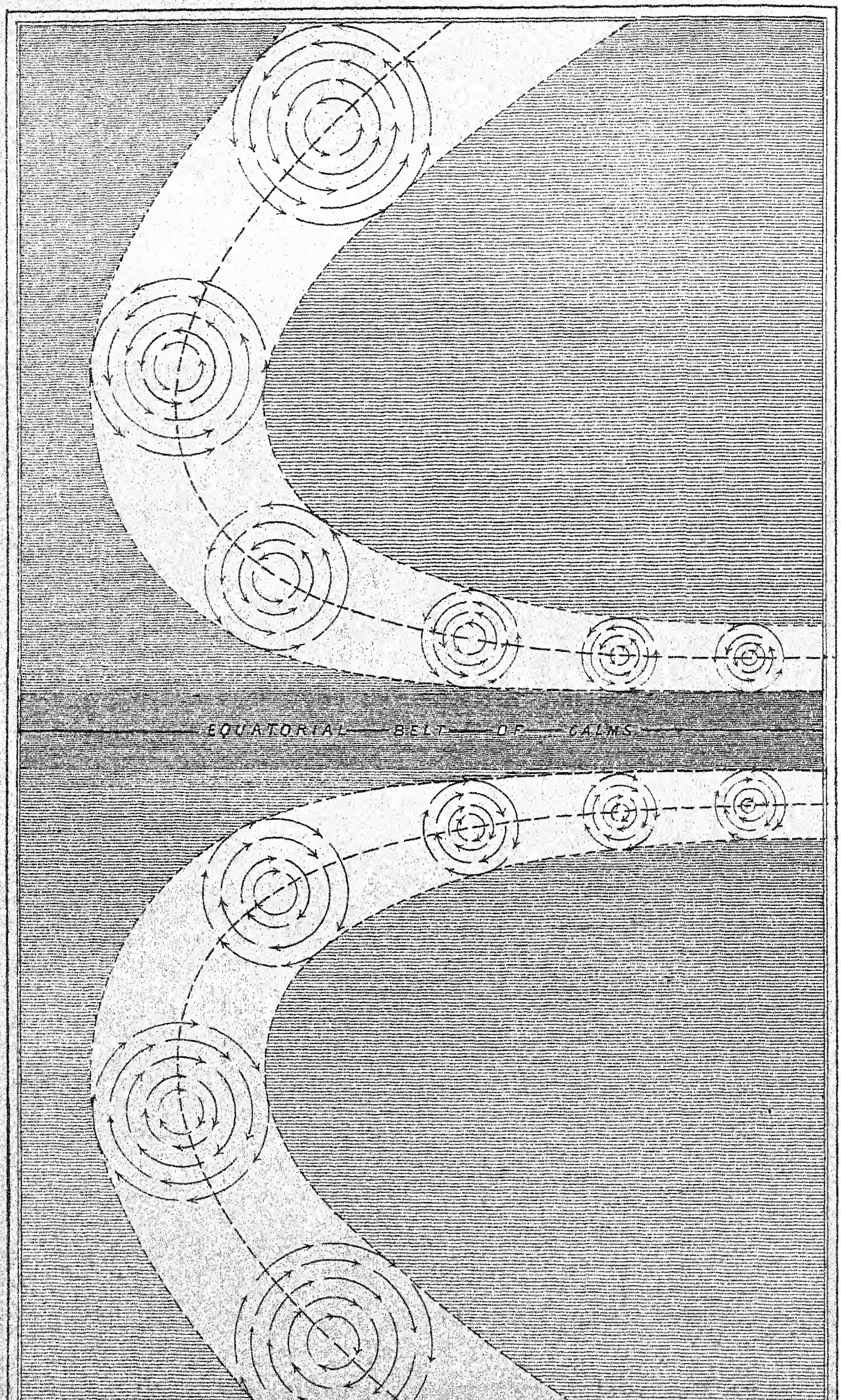
In islands in tropical climates we have alternate land and sea breezes, which are caused by the air ascending when heated by contact with the heated surface of the ground, and producing an influx of air in the evening, from the sea, which is then relatively much cooler; but, during the night, the surface of the land becomes relatively cooler, and in the morning the direction of the current of air is reversed. A very slight consideration will lead us to conclude that all continents cannot produce such results as have been referred to. If, for example, we have a continent with great ranges of snow-clad mountains, or even very elevated tableland, the effect produced by such a continent would be very different from that produced by a continent containing arid deserts like the interior of Africa or the great desert of Gobi. In the one, the air would be highly heated, in the other cooled, and the effects would be precisely opposite; but where there are elevated mountain ranges, the course of the wind is still further complicated by the new direction given to the wind in consequence of this obstruction.

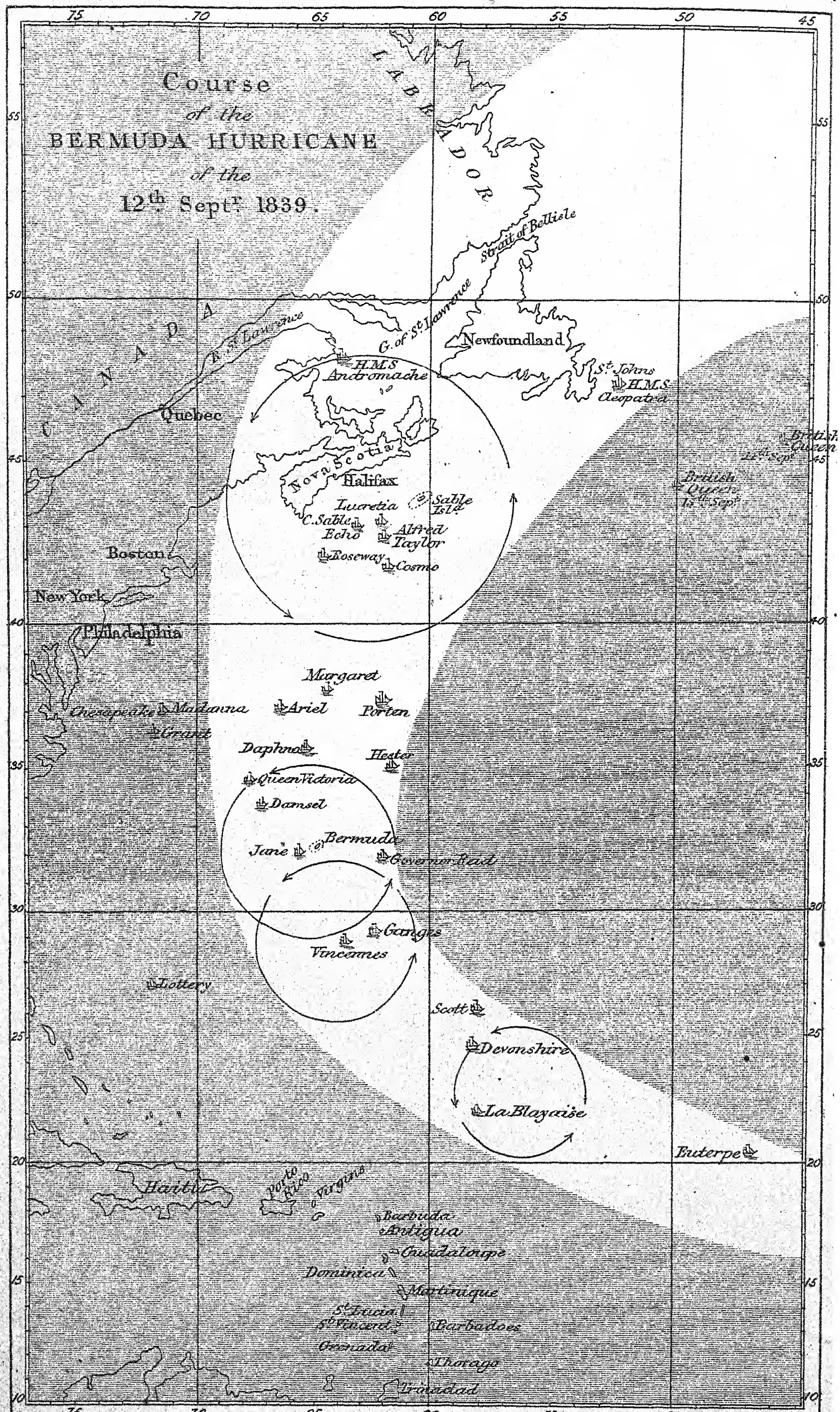
It will thus be seen how impossible it is from any general view of the subject to say, *à priori*, what will be the direction of the wind in every part of the earth, and at all seasons of the year. But the knowledge of the course of the wind, which cannot be obtained from theoretical investigations, may by a combined effort among meteorologists, be obtained so far as to enable us to say what will be its probable course at any place during any month or day of the year. The log-books of the vessels belonging to the military as well as commercial navies of almost every nation in Europe and America are now daily kept on an uniform system; the direction of the wind found to be blowing in every part of the ocean and at all seasons of the year is noted; and thus, in time, we shall have data from which the probable course of the wind can be ascertained and tabulated. From the individual exertions of Captain Maury we have already learned the route across the Atlantic in which the most favourable winds may be found at all seasons of the year, and it is impossible to over-estimate the advantages to navigation and science which the combined exertions of so many observers must produce; but, as I have before said, we require also a similar combination amongst observers on *land*.

NORMAL COURSE

OF REVOLVING STORMS ON EACH SIDE OF THE EQUATOR

PLATE. XIV




Course
of the
BERMUDA HURRICANE
of the
12th Septr. 1839.
LABRADOR
CANADA
Strait of Belle Isle
G. of St. Lawrence
R. St. Lawrence
Newfoundland
St. Johns
H.M.S. Cleopatra
H.M.S. Andromache
Quebec
Nova Scotia
Halifax
Sable Isld.
Lucretia
C. Sable
Echo
Alfred Taylor
Roseway
Cosmo
Boston
New York
Philadelphia
British Queen 14th Sept.
British Queen 13th Sept.
Margaret
Chesapeake
Madonna
Ariel
Porten
Grant
Daphne
Hester
Queen Victoria
Damsel
Jane
Bermuda
Governor Raid
Ganges
Vincennes
Lottery
Scott
Devonshire
La Blayaise
Euterpe
Haiti
Porto Rico
Virgins
Barbuda
Antigua
Guadaloupe
Dominica
Martinique
St. Lucia
St. Vincent
Barbadoes
Grenada
Tobago
Trinidad

2. Revolving Storms or Cyclones.

From the facts collected and published in the works of Colonel Capper and Mr. Piddington in India, Mr. Thorn in Mauritius, Mons. Quetelet and Professor Dove in Europe, Mr. Redfield and Captain Maury in the United States, and Colonel Sir W. Reid in the West Indies, we obtain a knowledge of the causes which produce revolving storms or hurricanes, and the law which governs their movements.

The easterly trade winds, flowing along the belt of equatorial calms, produce a precisely similar effect in the air of the atmosphere to that which may be observed in the water of any stream as it flows along the dead water behind a rock or any other obstacle to its course, namely, a constant tendency to produce whirlpools, which run along each side of the dead water, and which are always revolving towards it, and consequently on the one side they revolve in an opposite direction to that in which they revolve upon the other.

In the same manner aërial whirlpools or revolving storms are continually produced, and run westward along the equatorial belt of calms, and always revolve towards it; that is, in the northern hemisphere they revolve in a direction contrary to the movements of the hands of a watch, and in the southern hemisphere in the same direction as the hands of a watch. See Plate XIV.

It follows from this, that if during a revolving storm a person directly faces the wind, the centre of the storm must in the *northern* hemisphere be on his right hand, whilst in the *southern* hemisphere it will be on his left hand; and so again, if during one of these revolving storms the wind is observed to shift from one point of the compass to another, a second observation will indicate the direction in which the storm in its gyrations is proceeding, and practical rules for the guidance of navigators have been formed, by following which, a ship's head may be placed in such a direction as to carry her out of the storm.

Fortunately for the elucidation of this subject we have the log-books of several vessels which have been steered straight before the wind during these storms.

The "Charles Heddle" encountered one of these storms a little to the north of Mauritius, in about south latitude 19°, and her commander kept her scudding before the wind continuously for five days during which she was carried away to the south-west, but in her progress went five times round the central vortex of the storm.

Mr. Piddington has published an account of two storms which were raging at the same time and on the same meridian, within five degrees of the equator, but on opposite sides of it; and it has been clearly established, both in the Atlantic and Indian Oceans, that the normal course of these storms is a gyratory progress, first westward along the belt of equatorial calms, from which they sweep round in a curve, northward and southward, and pass away in a north-east and south-east direction. See Plate XIV.

The cause of which appears to be that the rotatory motion of the air, which commences in the lowest regions of the atmosphere,

is gradually communicated to that in the higher regions, where the revolving mass coming under the influence of the great current of the atmosphere towards the north-east and south-east is gradually turned from its westerly course along the belt of calms into a north-west or south-west direction, till it reaches the parallel of about 30°, when it is carried away in the great current to the north-east or south-east. See Plate XIV., which represents the normal course of revolving storms on either side of the equator.*

These storms progress at the rate of from 3 to 43 miles per hour, and the area included by them, as they advance, gradually expands from 100 to 500 miles in diameter, but the influence of a storm has been felt over an area of 1,500 miles in diameter.

The most recent account of a revolving storm which has been published, is that by Rear Admiral FitzRoy, the Director of the Meteorological Department of the Board of Trade. This account is given in the annual report of the Wrecks and Casualties on the coasts of the United Kingdom for the year 1859.

Admiral FitzRoy describes the storm of the 25th and 26th October last, in which the "Royal Charter" was wrecked on the north coast of Anglesea, as "a complete horizontal cyclone," the diameter of which was about 300 miles, and the centre of which passed over the Eddystone Lighthouse, and from thence in a north-east direction proceeded at the rate of about 20 miles an hour quite across England towards the North Sea. The influence of this storm was not felt on the west coast of Ireland.

Admiral FitzRoy also describes the storm of the 1st November 1859 as similar to the last, and as having also passed in a north-eastern direction along a line just to the west of Ireland.

An examination of the diagram of barometric pressure for October and November 1859, Plate XVI., gives further proof of the direction in which these storms passed; thus, it will be seen that the great depression which took place at Southampton at 9.30 P.M. on the 25th October occurred at Newry, Carlisle, and Newcastle at 9.30 A.M. on the 26th, and at Glasgow, Edinburgh, and Stirling at 3.30 P.M. on the 26th, giving a rate of progress, as Admiral Fitz Roy says, of about 20 miles an hour. Again, an examination of the same diagram shows that the great depression which occurred at 9.30 P.M. on the 31st October at Newry and Dublin, occurred at Stirling, Edinburgh, Glasgow, Newcastle, and Carlisle at 9.30 A.M. on the 1st November, and six hours later at Southampton, which indicates a more easterly direction in the course of the storm than in that of the 25th and 26th October.

It is unnecessary to point out the vast importance of being able to fortell the advent of a storm many hours before it could arrive at any of our ports, and Admiral FitzRoy, impressed with the idea that this can be done by the aid of the telegraph, has for some years past urged upon the Government the desirability of establishing telegraphic communications daily between our most distant ports, and especially from those in the south of Ireland.

* Plate XV., which is taken from Sir W. Reid's "Law of Storms," gives the actual course of a revolving storm north of the equator.

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3. Atmospheric Waves.

That great waves traverse the atmosphere in various directions is a fact which has long been recognized by meteorologists, and they have been made the subject of several very interesting essays and reports by Howard, Sir W. Herschel, Kreil, Birt, Sabine, and others; and by M. Quetelet, in his admirable work on the climate of Belgium; and by Professor James Espy, in his report on the meteorology of the United States.

The extent, the course, and the velocity with which these great waves progress, have been traced by selecting the well-defined *maxima* and *minima* of the barometric curves, and by drawing lines through the stations at which these *maxima* and *minima* were simultaneously observed.

From the observations made at the Ordnance Survey Office, Phœnix Park, Dublin, the recurrence of a great symmetrical wave in the month of November, in the years from 1829 to 1845 inclusive, has been recognized. Those of 1833, 1834, and 1838, commenced their passage on the 7th of November. The transit of the anterior trough of each wave was on that day, of the apex of the wave on the 12th, 13th, and 14th, and the transit of the posterior trough in each case occurred on the 21st, making the time of passage in each case 14 days. In the diagram of barometric pressure for the month of November 1857, Plate XVII., the passage of a great atmospheric wave is clearly indicated as crossing the United Kingdom between the 11th and 12th of the month, and from the circumstance that the apex of the wave seems to have passed simultaneously over Belfast and Edinburgh, and 12 hours before it passed over Southampton; this wave appears to have come from the north-west.

On the diagram for October and November 1859, Plate XVI., we again trace the passage of this great annual wave, and here it seems again to have come more directly from the north-west, as the apex passed Newry some hours before it passed Dublin or any of our stations in Scotland or England.

An examination of the diagram for November 1859 gives similar evidence of the passage of atmospheric waves or storms in an easterly direction across the stations in North America, the depression of the barometer at Kingston, Canada West, occurring at 3.30 P.M. on the 10th; at Halifax, at 9.30 A.M. on the 11th; and at Newfoundland on the 12th at 9.30 A.M.*

The study of the diagrams for the Mediterranean stations also clearly indicate the passage of waves from west to east.

Mr. Birt, in his report on atmospheric waves to the British Association, in 1845, says, "In the case of a large wave stretching "over an extensive area, the anterior and posterior trough would "mark out parallel or nearly parallel lines of least pressure; the "molecular movement would be strongest in those troughs, and "directed towards them from each side; at stations removed from

* See the lines A, B, C, D, on the diagram.

"them the force of the wind would be greatly diminished, and at "the intervening crest it would be so small as scarcely to be "appreciable; but however small it might be upon the crest "passing any station, the direction of the wind at that station "would be reversed, and it would increase in intensity until the "transit of the posterior trough."

This important and very interesting fact was deduced by Colonel Sabine from the Toronto Observations; and Professor Espy has shown that the increased pressure of the atmosphere, caused by the passage of a wave, is attended with a rise of temperature, and that the expansion of the atmosphere in the troughs produces a diminution of temperature; and thus the cause which produces a frequent change of wind at the surface of the earth, and a change of temperature with those changes in the wind, is clearly traced to the passage of atmospheric waves in different directions, and prove that for a perfect understanding of the general course in which the atmosphere circulates, we must study the direction in which these waves traverse the surface of the earth, rather than the varying direction of the wind caused by their passage.

4. Aqueous Vapour in the Atmosphere.

Few subjects have given rise to a greater diversity of opinion amongst meteorologists than that which refers to the manner in which the aqueous vapour in the atmosphere is mixed with the dry air, and affects the barometer by its presence.

On the one hand it is contended that the vapour floats in the air, and that the effect of its presence is to diminish the weight or pressure of the atmosphere, the specific gravity of a mixture of air and vapour being less than that of an atmosphere of air only.

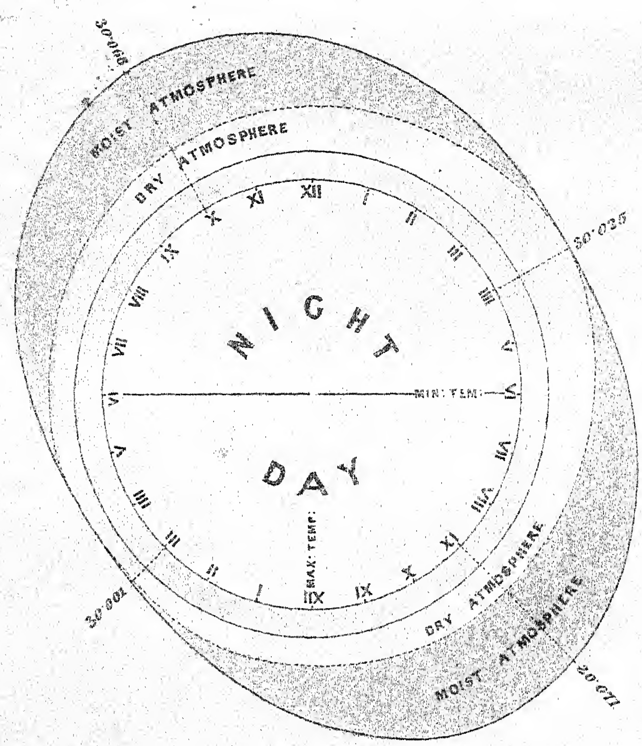
On the other hand, many eminent meteorologists contend that in a mixed atmosphere of air and vapour the two component parts permeate each other and act separately, and that whilst the height of the barometer indicates the pressure of the whole compound atmosphere, the elastic force of the vapour at the earth's surface indicates the weight of all the vapour in the atmosphere, and that we can obtain the pressure of the dry air only by deducting the elastic force of the vapour from the height of the barometer.

This last view of the subject has been utterly annihilated by the facts obtained during the balloon ascents in 1852.

Mr. Welsh found that the elastic force of the vapour did not diminish with the altitude gained, as it ought if this view were correct, but, on the contrary, that the elastic force at 800 feet high was greater than it was on the ground, and that at 3,000 feet it was much greater still. Similar results were obtained even at the great height of 8,500 feet, where the tension of vapour was greater than at the height of 6,000 feet.

Corresponding results have been obtained from simultaneous observations on the summit and at the foot of a mountain, and consequently the idea that the pressures of the air and vapour act independently must be abandoned; every cloud in the heavens is a witness of its fallacy.

DIURNAL ATMOSPHERIC TIDES.



ISOTHERMAL LINES OF MEAN ANNUAL TEMPERATURE

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5. Diurnal Atmospheric Tides.

If a circle is divided into 24 parts, representing the 24 hours of the day, and the mean height of the barometer for each hour of the day is set off vertically upon the circle, we shall have a pretty correct idea of what are called the diurnal atmospheric tides.

In the diagram, Plate XVIII., the mean height of the barometer at the Mauritius for the years 1852-3-4-5-6, at about 3½ P.M., at which hour the barometer is at its lowest point, has been deduced from the height of the barometer taken hourly on the *term* days, and the heights set off on an imaginary atmospheric zone.

It will thus be seen that the maximum pressure of the atmosphere during the 24 hours is at about 9½ A.M., that the pressure gradually decreases till about 3½ P.M., when it reaches the minimum of the 24 hours; that it then gradually increases till about 9½ P.M., and again gradually decreases till about 3½ A.M.

This gradual increase and decrease twice in the 24 hours has given rise to the idea of aerial tides regularly ebbing and flowing.

The same fact has been observed in all parts of the world, in India and America as well as in Europe, and in every place where there are large bodies of water from whence supplies of aqueous vapour may be obtained; and the regularity in the march of the barometer is such within the tropics that the hour of the day may, under ordinary circumstances, be inferred to within about a quarter of an hour from the height of the barometer.

But "in the interior of great continents, very distant from the " ocean or from large bodies of water from which supplies of " aqueous vapour may be derived, and where the air is conse- " quently at all times extremely dry, the double maximum and " minimum of the diurnal variation of the barometer either wholly " or almost wholly disappears, and the variation consists in a " single maximum and minimum, which occur respectively nearly " at the coldest and at the hottest hours of the day, the greatest " height of the mercury being at or near the coldest hour, and " the least height at or near the warmest hour." *See* General Sabine's note in his translation of " Cosmos."

It is obvious from these facts, that the great rise of the barometer at about 9½ A.M. and about 9½ P.M. is due to the action of the aqueous vapour in the atmosphere, and I think Professor James Espy rightly interprets its cause in attributing the first maximum, at about 9½ A.M., to the expansive energy or quasi explosive force of the rising vapour under the increasing temperature of the day; and the second maximum, at about 9½ P.M., to the momentum of the descending vapour when its density is increased by the reduction of temperature in the evening. We must therefore regard the increase of the pressure of the vapour at these points as the result of a dynamical force, and not simply as due to the weight of the atmosphere acting statically.

6. Isothermal Lines.

The mean annual temperature of a great number of places in different parts of the globe has been determined from observations, and from the data thus obtained lines connecting the points

of equal mean annual temperature have been drawn, as in Plate XIX. These lines are called isothermal lines, and maps of the world, with such lines on them, have been constructed by Humboldt, Dove, and other meteorologists.

If a line be drawn from the pole down the meridian of 20° west longitude, passing along the east coast of Greenland, through Iceland, and through the Azores, Canary, and Cape de Verd Islands, and by Sierra Leone to the Gulf of Guinea, as far as the equator, this line may be taken as the line upon which the mean annual temperature follows the *normal law of its variation in latitude*, for upon this line the mean annual temperature varies as the cosine of the latitude.

It will be seen by reference to Plate XIX. that to the east of this line the isothermal lines take a northerly direction, whilst to the west of it the lines are depressed towards the south; the elevation of those on the east being caused by the warmth of the Gulf Stream, which crosses the Atlantic from the Gulf of Mexico, and flows northward through the British Islands and along the coast of Norway towards the Arctic regions, whilst the depression of the isothermal lines to the west of the *normal line* is caused by the flow of the cold waters from the polar regions, through Davis's Straits, southward. Sir Leopold McClintock, in his last voyage in search of Sir John Franklin's expedition, was enclosed by ice in Davis's Straits, and drifted southward by this current for the enormous distance of 1,500 miles, before he was released. Whilst, in proof of the direction of the Gulf Stream, independent of the increased temperature always observed on entering it, we have the fact that the plants of the West Indies, with the tropical shells attached to them, are not unfrequently found upon our coast, more especially in the west of Ireland. And again, from the singular fact that the icebergs coming out of Davis's Straits actually cross the Gulf Stream, we have a proof that the cold stream from the polar regions crosses and flows under the warmer stream from the Gulf of Mexico. For as, from the specific gravity of ice, four-fifths of the mass of the icebergs is always under water, the lower and larger portion of the iceberg is carried along by the colder under-current, and across the warm stream, which acts only against the upper and smaller portion.

If, again, we draw a line from the pole, connecting the observatories of Torneo, Stockholm, Copenhagen, Greenwich, Paris, and as far as Gibraltar, we find that along this line the mean annual temperature also follows the normal law of its variation in latitude, excepting in that part where it crosses the centre of Spain.

But, as may be seen by the course of the isothermal lines, no single law of variation can possibly be applicable to all parts of the earth.

Professor James Forbes, however, in a recent communication to the Royal Society of Edinburgh, has given formulæ in which the physical features of the globe in relation to climate are taken into consideration; but it will be difficult in practice to apply these empirical formulæ. Mr. O'Farrell, of the Ordnance Sur-

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Guildhall Chamberlain

vey, has, however, deduced an important result from one of his formulæ. He says, "Assuming the mean annual temperature of "the North Pole (2°·3 Fahr.) obtained by Dove (Distribution of "Heat, p. 13,) and verified by Professor Forbes (Inquiries about "Terrestrial Temp., p. 80,) we may, by means of the formula or "law (par. 33, p. 85,) which seems to agree so well with all the "existing observations, infer with some degree of probability the "proportion of land and water existing in the vicinity of the "North Pole. For, inserting 2°·3 instead of T_{λ}, in the equation "referred to, we have (L' being the relative proportion of land)

$$\text{"}2^{\circ}{\cdot}3 = 12^{\circ}{\cdot}5 - 38^{\circ}{\cdot}1\,L'$$

$$\text{from which } L' = \frac{10^{\circ}{\cdot}2}{38^{\circ}{\cdot}1} = {\cdot}268$$

"that is, the proportion of land is a little more than one-fourth "of the whole, and consequently the proportion of land and "water, or rather that of the solid to the fluid surface, is as 1 to "3 nearly."

As the mean annual temperature of any place approximately varies as the cosine of the latitude, if we take the mean temperature at the equator at 80°, and divide the radius as in the diagram Plate XX., into a scale of 80 equal parts, and let fall perpendiculars upon it from any point in a given latitude, we can see by mere inspection what is the approximate mean temperature of that point at the level of the sea.

The following table gives the mean temperature as it varies with the cosine of the latitude, that at the equator being assumed to be 80°.

Latitude.	Approximate Mean Temperature. 80° cos. latitude.	Mean Temperature, Minus 32°.	Resulting Mean Height of Perpetual Snow. See page 44.
°	°	°	Feet.
0	80·0	48·0	14,400
5	79·7	47·7	14,310
10	78·8	46·8	14,040
15	77·3	45·3	13,590
20	75·2	42·2	12,660
25	72·5	40·5	12,150
30	69·3	37·3	11,190
35	65·5	33·5	10,050
40	61·3	29·3	8,790
45	56·5	24·5	7,350
50	51·4	19·4	5,820
55	45·9	13·9	4,170
60	40·0	8·0	2,400
65	33·8	1·8	540
66 25′	32·0	0·0	0
70	27·4	— 4·6	Below the Surface.
75	20·7	—11·3	
80	13·9	—18·1	
85	7·0	—25·0	
90	0·0	—32·0	

Height of the Perpetual Snow-Line.

It is found, from observations taken in balloons, that the temperature decreases 1° for every 100 yards in altitude. If, then, we take the temperature of any place at the sea level from the Isothermal Map, and deduct 32° from it, and multiply the difference by 300 feet, we shall have the average height in feet of the line of perpetual snow at that place.

Thus, the temperature at the Equator being assumed to be 80°

$$\begin{array}{r} 80^\circ \\ 32 \\ \hline 48^\circ \\ 300 \\ \hline \end{array}$$

14,400 feet is the height of the snow line under the equator; and in the same way we can trace the height of the snow-line as it descends in going north or south from the equator towards the poles, and in latitude 66° 25′ it meets the surface of the earth, and in the Arctic regions the line of perpetual frost descends below the surface of the earth.

This is represented in Plate XX.

If we now divide the interval between the surface of the earth and the line of perpetual snow under the tropics into five or six zones, and draw these zones parallel to the snow-line, we obtain the general law of the distribution of the flora on the surface of the earth. Under the equator these zones on the sides of mountains represent the zones or belts in which the different kinds of plants or trees grow, as the zones of palms, oaks or firs, &c., and tracing these zones north and south of the equator, we see the latitudes beyond which the different kinds of vegetables or trees do not grow. Thus a snow-clad mountain under the tropics is typical, as regards its flora, of the hemisphere of the globe itself, with its pole covered with perpetual snow, and zones of latitude, with their distinctive vegetation. In the Arctic regions the ground beneath the surface is perpetually frozen, although the heat of the sun at midsummer is so considerable as to thaw the surface sufficiently for the growth of plants.

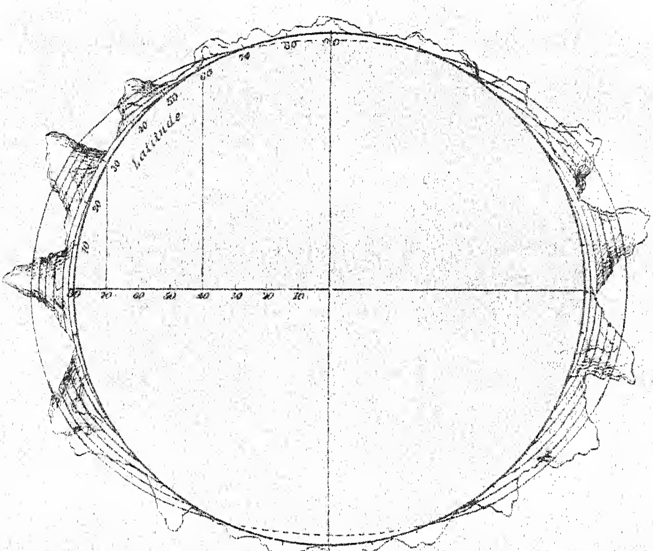
Beneath the surface of the earth the temperature increases at the rate of 1° for every 60 feet, but the temperature in the first 60 feet is influenced by the seasons, the effect, however, having what is called a great "drag," arising from the slow rate at which the rocks and stony matter conduct the heat. Thus it has been observed in deep caverns that the effect of the great heat of summer has only been felt in their furthest recesses during midwinter, and *vice versâ*, the cold of winter only reaches them at midsummer.

Professor Hopkins infers from the law of increase of temperature with the depth, that the solid crust of the earth must be from

APPROXIMATE MEAN TEMPERATURE OF ANY PLACE

AND

HEIGHT OF LINE OF PERPETUAL SNOW.



EXAMPLE.—Suppose Lat. = 29°.
Perpendicular or sine let fall on scale reads 70
then 70−32 = 38.
and 38×300 = 11400 Feet.

Allahabad Christian College

200 to 300 miles thick; that at about this depth the rocks and the whole interior mass of the earth are in a fluid state; and further, that in consequence of its fluidity the central mass has a greater ellipticity than the exterior crust, and consequently that the hardened crust is thicker at the poles than in the equatorial regions. It would also seem to follow, as a necessary corollary from this, that independent of the effect of the sun or any external cause, the equatorial regions would be warmer than the polar or any intermediate portion of the earth.

7. Isobarometric Lines.

Mean Height of the Barometer at the Level of the Sea, according to MM. Schouw and Poggendorff, and the Officers of the Royal Engineers.

Places.	Latitude.	Height of Barometer at the Level of the Sea, at 32° Fah.	Places.	Latitude.	Height of Barometer at the Level of the Sea, at 32° Fah.
	° ′	Inches.		° ′	Inches.
*Auckland -	37 0 S.	30·001	Bologna - -	44 30	30·008
Cape - -	33 0	30·040	Padua - -	45 0	30·008
Rio Janeiro -	23 0	30·080	*Newfoundland -	47 30	29·922
*Mauritius -	20 0	30·077	Paris - -	49 0	29·977
Christianburg -	5 30 N.	29·926	*Guernsey - -	49 30	29·982
*Colombo, Ceylon	7 0	29·928	London - -	51 30	29·960
La Guayra -	10 0	29·928	Altona - -	53 30	29·938
*Barbadoes -	13 0	29·950	Dantzic - -	54 30	29·926
*Jamaica - -	18 0	30·026	Konigsberg -	54 30	29·941
Saint Thomas -	19 0	29·942	Apenrade -	55 0	29·905
*Hong Kong -	22 0	29·995	*Edinburgh -	56 0	29·872
Macao - -	23 0	30·039	Christiania -	60 0	29·868
*Bahamas - -	25 0	30·089	Hardanger -	60 0	29·801
Teneriffe - -	28 0	30·088	Bergen - -	60 0	29·804
Madeira - -	32 30	30·126	Upenavik -	63 0	29·732
Tripoli - -	33 0	30·214	Reikiavig -	64 0	29·607
*Gibraltar - -	36 0	30·095	Godthaab -	64 0	29·604
Palermo - -	38 0	30·038	Eyafiord - -	66 0	29·669
*Corfu - -	39 30	30·017	Godhaven -	68 0	29·676
Naples - -	41 0	30·014	Melville Isle -	74 30	29·807
Florence - -	43 30	29·998	Spitzbergen -	75 30	29·794
Avignon - -	44 0	30·001			

The mean height of the barometer in the Pacific Ocean along the West Coast of South America is lower than it is on the Atlantic side, and this is probably due to the partial vacuum caused by the interposition of the great chain of the Andes across the prevalent direction of the wind.†

* These are the Stations of the Royal Engineers.

† See "Paper on the Oscillation of the Barometer, in the Transactions of the Royal Society of Edinburgh." By Captain Henry James, R.E.

Mean Diurnal Oscillation of the Barometer in different Latitudes.

Professor James Forbes has given the following equation for finding the mean oscillation of the barometer in any part of the world:—

$$z = -\cdot 015 + \cdot 1193 \text{ Cosine}^{\frac{5}{2}} \theta$$

z being the oscillation in inches in latitude θ; this gives the equatorial oscillation $+\cdot 1043$ inches, and for the poles $-\cdot 015$.

The latitude where the oscillation changes its sign, or is 0, is 64° 8′ 6″; beyond this the mean height of the barometer is greater at 4 P.M. than at 10 A.M., the reverse of what takes place below the latitude of 64°.

This change in the order of the daily maximum and minimum in the higher latitudes might, as Professor Forbes truly says, have been deduced from theory before it was observed by Sir Edward Parry.

The following table shows the remarkable agreement between the observed mean oscillation at the Royal Engineer Stations and those calculated from the above equation; but we are not quite certain that the entire amount of oscillation is obtained from the $9\frac{1}{2}$ A.M. and the $3\frac{1}{2}$ P.M. observations.

Names of Stations.	Latitude.	Oscillation from $9\frac{1}{2}$ A.M. to $3\frac{1}{2}$ P.M.	Computed Oscillation.	Difference.
	° ′			
Edinburgh - -	55 58	0·014	0·013	0·001
Guernsey - -	49 33	0·023	0·025	0·002
Newfoundland - -	47 35	0·023	0·029	0·006
Quebec - - -	46 48	0·049	0·031	0·018
Corfu - - -	39 37	0·034	0·047	0·013
Gibraltar - -	36 6	0·041	0·055	0·014
Malta - - -	35 54	0·038	0·055	0·017
Hong Kong - -	22 16	0·085	0·083	0·002
Jamaica - - -	17 59	0·064	0·090	0·026
Barbadoes - -	13 4	0·046	0·096	0·050
Ceylon - - -	6 56	0·104	0·102	0·002
Mauritius - -	20 10	0·067	0·086	0·019
Fremantle - -	32 15	0·041	0·063	0·022

Sir Edward Parry, whilst at Port Bowen, in latitude 73° 48′, found the oscillation to be 0·009; calculated by the formula it is 0·010.

8. Rain.

The capacity of dry air to receive the vapour of water depends upon its temperature, and when the air is not already saturated with vapour evaporation proceeds at all temperatures, either from water, ice, or snow.

The atmosphere consequently has a greater capacity to receive vapour in the tropical than in any other regions of the earth; and where, as in the region of calms across the great oceans, there

is a full supply of vapour, or across the lands over which the warm vapour-laden winds are carried, the fall of rain is enormously great, the quantity which falls in one day often exceeding the fall at Greenwich in twelve months.

But where, on the contrary, the air is very warm, and there is not a sufficient supply of vapour, as in Central Africa, and, during the north-east monsoons in Central India, there is no rain, and the excessive dryness and thirstiness of the air destroys vegetation, and produces the most disagreeable effects upon the human frame.

Fall of Rain at the Royal Observatory, Greenwich.

Taking December, January, and February as the winter months; March, April, and May as the spring months; June, July, and August as the summer months; September, October, and November as the autumn months, the quantities which fell in the different seasons were as follows:—

—	1842.	1843.	1844.	1845.	1846.	1847.	Mean.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
Winter -	2·81	4·14	5·16	5·33	5·42	4·77	4·60
Spring -	4·42	5·98	3·59	4·27	5·43	3·16	4·47
Summer -	5·69	7·34	6·63	6·84	6·00	4·12	6·10
Autumn -	9·65	7·01	9·58	5·90	8·44	5·56	7·69
Total -	22·57	24·47	24·96	22·34	25·29	17·61	22·86

The quantity of rain which fell at the Royal Engineers stations during the year 1853-4, was as follows:—

	Inches.		Inches.
Edinburgh - -	23·15	Barbadoes - -	68·24
Guernsey - -	32·77	Ceylon - - -	71·63
St. John's - -	55·05	Mauritius - -	39·52
Gibraltar - -	47·29	Fremantle - -	33·94
Malta - - -	28·08	New Zealand - -	48·42
Jamaica - - -	34·31		

The district of Cutch, at the mouth of the Indus, is all but a rainless district, but in the Khassya hills, north of Calcutta, the annual fall amounts to 600 inches or 50 feet, eleven-twelfths of which descend in the six rainy months; Professor Oldham measured a fall of 25·5 inches in one day.

From experiments made by Dr. Heberdeen at Westminster Abbey in 1776, by Professor J. Phillips at York Minster in the years 1832-3-4-5; by Mr. Littledale in 1834-5, at Bolton Church, Yorkshire; by Mr. J. F. Miller, in the years 1844-5-6-7, at St. James's Church, Whitehaven; by Dr. Buist, in the years 1843-4, at the Bombay Observatory; and from the observations made at the Royal Observatory at Greenwich, the fact is clearly established that in the lower regions of the atmosphere, the quantity of rain which falls diminishes with the altitude above the ground.

The following results were obtained from the observations at Greenwich:—

——	1842.	1843.	1844.
	Inches.	Inches.	Inches.
Anemometer gauge, 50 feet above the ground - - - - -	12·63	14·88	14·62
Library gauge, 24 feet above the ground	20·03	22·12	22·19
Crosley's gauge, 1 foot 11 inches above the ground - - - -	21·44	22·53	21·28
Cylindrical gauge, 5½ inches above the ground - - - -	22·57	24·47	23·20

The results obtained at the Royal Engineer stations are in general in accordance with those obtained in this country, and are exhibited in the following table:—

		Inches.
St. John's, Newfoundland	20 feet above the ground -	40·06
	On the ground - -	55·05
Gibraltar - -	25 feet above the ground -	46·25
	On the ground - -	47·29
Malta - - -	20 feet above the ground -	24·44
	On the ground - -	28·07
Jamaica - - -	40 feet above the ground -	25·88
	On the ground - -	34·31
Barbadoes - -	20 feet above the ground -	59·13
	On the ground - -	68·24
Ceylon - - -	23 feet above the ground -	69·29
	On the ground - -	71·63
Mauritius - -	28 feet above the ground -	34·33
	On the ground - -	39·52
New Zealand - -	30 feet above the ground -	31·77
	On the ground - -	48·42

The Guernsey observations are not in accordance with the above, but the disagreement at this station is probably owing to the position of the gauges not being well selected.

The cause of the increased quantity of the rain at the lower levels may be explained by supposing that as the cold drops of rain descend through the moist atmosphere, they continue to condense moisture on themselves and to increase in bulk and quantity the further they are allowed to proceed in their descent.

The experiments of Mr. Miller in the mountainous lake district of Cumberland and Westmoreland, described by that gentleman in the Philosophical Transactions for 1849, and the results obtained in India, which are so ably discussed by Lieutenant-Col. Sykes in the Philosophical Transactions for 1850, prove that in mountainous districts the quantity of rain which falls at stations at different altitudes, increases with the altitude of the station up to a certain height, and then again diminishes; this height was found in the lake district to be at about the height of 2,000 feet, and in India at an altitude of 4,500 feet above the level of the sea.

The following table is taken from Mr. Miller's paper :—

——	Altitude above Level of the Sea.	Inches.
	Feet.	
The Valley - - - -	160	170·55
Stye Head - - - -	1,290	185·74
Scatollar Common - - -	1,334	180·23
Sprinkling Tarn - - -	1,900	207·91
Great Gable - - - -	2,925	136·98
Sea Fell - - - -	3,166	128·15

The following is taken from Lieutenant-Col. Sykes's paper :—

	Inches.	
Mean at seven stations at sea-level - -	81·70	
At 150 feet—Rutnagherry - - -	114·55	
At 900 feet—Dapoolee - - - -	134·96	
At 1,740 feet—Kundalla - - -	141·59	
At 4,500 feet—Mahabuleshwur - - -	254·05	
At 4,500 feet—Mercara - - -	143·36	+
At 4,500 feet—Uttray Mullay - - -	263·21	
At 6,100 feet—Kotergherry - - -	81·71	
At 8,640 feet—Dodabetta - - -	101·24	

In explanation of this phenomenon Mr. Miller observes, "The " warm south-westerly current arrives at the coast loaded with " moisture obtained in its transit across the Atlantic; now our " experiments justify us in concluding that this current has its " maximum density at about 2,000 feet above the level of the sea: " hence it will travel onward till it is obstructed by land of " sufficient elevation to precipitate its vapour, and retaining a " portion of the velocity of the lower parallel of latitude whence " it was originally set in motion, it rapidly traverses the short " space of level country and with little diminution of its weight or " volume; but on reaching the mountains it meets with a tem- " perature many degrees lower than the point at which it can " continue in a state of vapour, sudden condensation consequently " ensues in the form of a vast torrent of rain, which in some " instances must descend almost in a continuous sheet, as when " nine or ten inches are precipitated in forty-eight hours."

Lieutenant-Col. Sykes says, "The explanation of the prodigious " fall of rain at the level of 4,500 feet is simple and satisfactory. " The chief stratum of aqueous vapour brought from the equator " by the south-west monsoon is of a high temperature, and floats " at a lower level than 4,500 feet; indeed, I have looked over or " upon the surface of the stratum at 2,000 feet. It is dashed with " considerable violence against the western mural faces of the " Ghâts, and is thrown up by these barriers in accumulated masses " into a colder region than that in which it naturally floats; it is " consequently rapidly condensed, and rain falls in floods."

Marine Barometer.

Marine barometers are of various construction, but they are almost always made with closed cisterns, and therefore, for strict accuracy, require the correction for "*capacity*;" but as they are generally considered only as "weather glasses," the sailor being more concerned to know whether the barometer is rising or falling, than to know the exact amount of the rise or fall, or the absolute height of the mercury, this correction is generally omitted in the records inserted in the log books. In the marine barometers recommended by Admiral FitzRoy, however, the correction for capacity is practically made by dividing a true inch in the ratio of the sectional area of the tube to that of the cistern, as, for example, in the ratio of 1 to 19, *i.e.*, dividing the inch into ·05 and ·95, and making each division on the scale equal to ·95 of an inch. This will represent a true inch, because when the mercury rises in the tube to the extent of ·95 it will fall in the cistern to the extent of ·05, and the actual rise or difference of level between the height of the mercury in the tube and that in the cistern will be in reality an inch.

Marine barometers require to be so constructed that they may be easily and safely transported from place to place, as from one vessel to another, in boats; to be strong to meet the concussion, from the firing of guns or other accidental concussions, and to have their tubes so constructed as to prevent the oscillations, or "*pumping*" as it is technically called, which the motion of the vessel tends to produce.

These conditions are found combined in the marine barometers now supplied for Her Majesty's Service, and which have been greatly improved under the directions of Rear-Admiral FitzRoy. A drawing of this instrument is given in Plate XXI., and of the spare tube with its attached cistern, which is supplied in the same box with the instrument; a line is cut on the tube to mark its exact proper position with reference to the scale which it will be in when this line coincides with the height of 27 inches. The scale is graduated to the one hundredth of an inch only, and is made of porcelain.

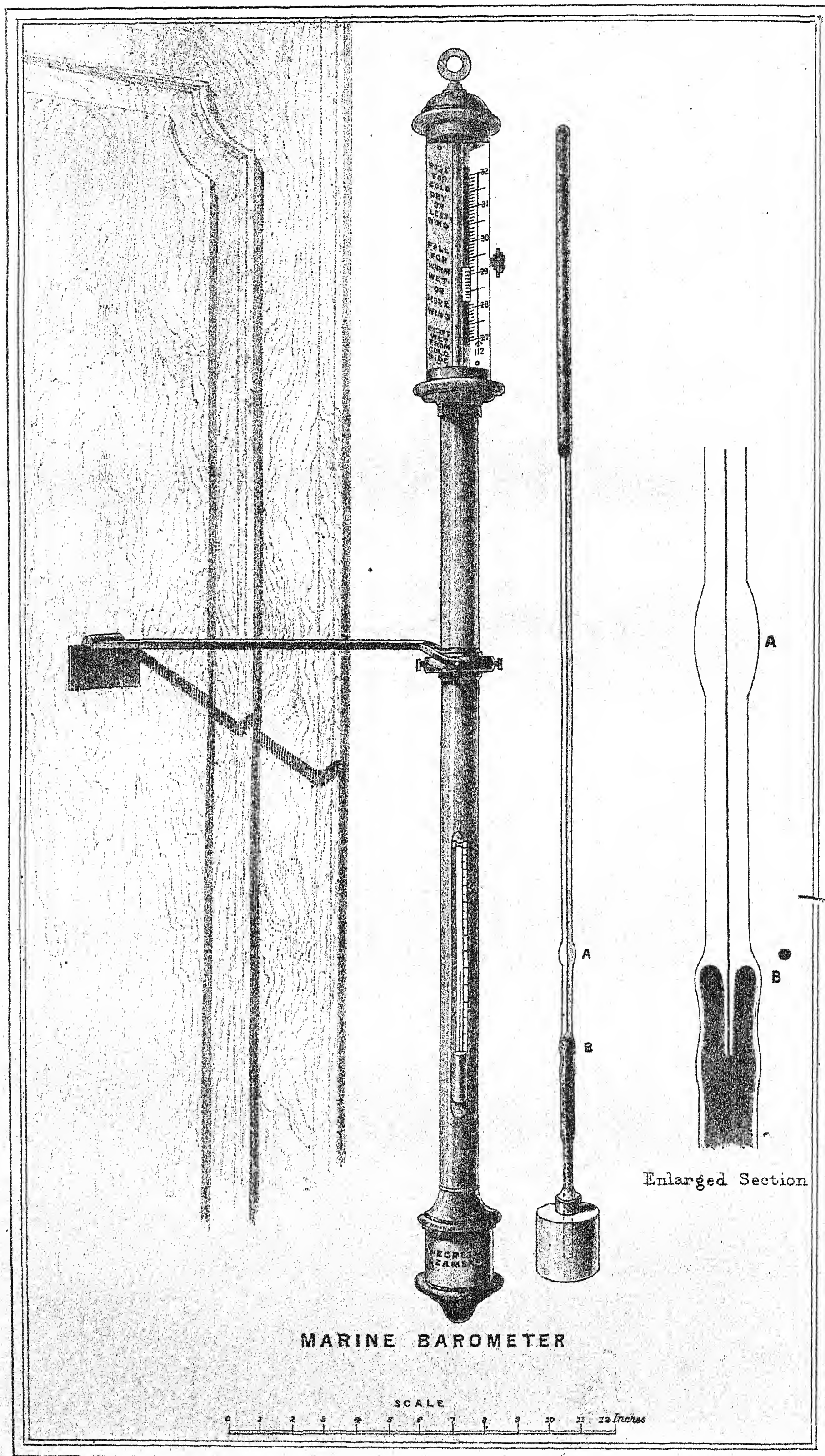
To prevent "*pumping*," the tube through the greater part of its length is made very small, and this small portion is constricted at (A) so as to leave a very narrow passage for the mercury.

A "pipette" is inserted in the tube at (B) to prevent the ascent of air in it.

The following directions for shifting a tube are given by Admiral FitzRoy:—

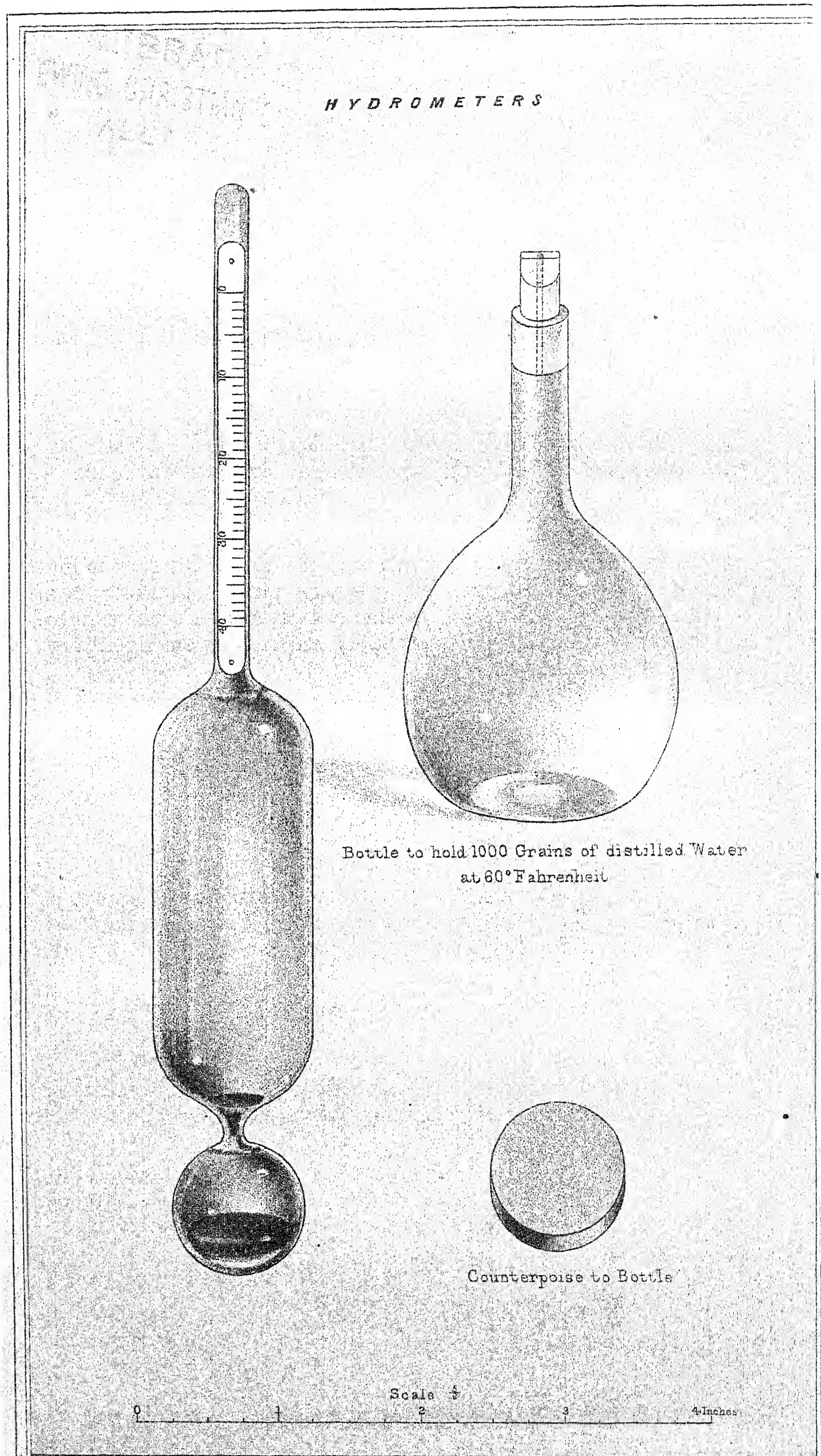
"To Shift a Tube.—*Incline* slowly—and take down the barometer, allowing the mercury to fill the upper part. Lay the instrument on a table, unscrew the outer cap, at the joining just below the cistern swell, then unscrew the tube *and* cistern,

Geelahad Clinton Coll...



MARINE BAROMETER

Drawn and Lith.^d by J. Ferguson.



Bottle to hold 1000 Grains of distilled Water at 60° Fahrenheit

Counterpoise to Bottle

Drawn and Lith.d by J. Ferguson

by turning the cistern gently against the sun, or to *the left*, and draw out the tube very carefully, without in the least *bending* it,—*turning* it a little, if required, as moved. Then unscrew the cistern collar at the place next to the swell, joining the brass tube. Take off the packing, by cutting the threads, and, if necessary, slitting the *whole* length with scissors (all the packing rubber should be so cut). After putting the brass collar on the spare glass tube, tie the packing to it closely, at three places. Then insert the new tube very cautiously, screw on collar, and adjust to 27 inch mark. Attach the cap, and suspend the barometer for use.

"In about ten minutes the mercurial column will be nearly right, but as local temperature affects the brass, as well as the mercury, slowly and very unequally, it may be well to defer any *exact comparisons* with *other instruments* for some few hours.

"Robert FitzRoy."

"January 1, 1861."

The barometer is hung in gimbals at the end of the supporting arm, which is of steel, and being elastic prevents jerking in a vertical direction; if a small portion of this arm were turned into a vertical position, it would probably aid in preventing injury from lateral concussion.

Hydrometer.

The instruments used for determining the specific gravity of water are called hydrometers.

The one figured in Plate XXII. is of the form recommended by Rear-Admiral FitzRoy; it is made of glass, and has a graduated ivory scale in the narrow stem at top, the 0 or zero of which indicates the height at which the instrument will float in distilled water of the standard temperature of 60°, the mercury or small shot in the bulb at the lower end causing the instrument to float upright.

The scale is graduated from 0 to 40, and the readings run 1,000, 1,001, 1,002, 1,003 to 1,040.

A cubic foot of distilled water weighs 1,000 ounces, and therefore the actual weight of a cubic foot of any other water, as that of the sea, which is about 1,020, is obtained at once by the indications of the hydrometer.

The specific gravity of the water of the Dead Sea has been variously estimated at from 1·18 to 1·24, and an instrument graduated differently from the one described would be required to measure it.

Specific Gravity Bottle.

A small bottle with a ground and perforated stopper, like that figured in Plate XXII., is generally used in the laboratory for accurately determining the specific gravity of fluids of all kinds.

The bottle is made to hold 500 or 1,000 grains of distilled water at the temperature of 60°, and a counterpoise to the weight of the bottle being given, the specific gravity of any other fluid is at once obtained by weighing the bottle full of it. If a 500 grain bottle is used the weight must of course be doubled.

The weighing with the accuracy required could not be done at sea.

TABLES

FOR THE

REDUCTION OF THE METEOROLOGICAL OBSERVATIONS

TAKEN AT

THE STATIONS OF THE ROYAL ENGINEERS.

PRINTED BY ORDER OF THE SECRETARY OF STATE FOR WAR.

EDITED

BY

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APPENDIX

TO

INSTRUCTIONS FOR TAKING METEOROLOGICAL OBSERVATIONS, 1860.

TABLE I.

Correction for Capillarity.

The Depressions are for unboiled tubes. Where the Mercury has been boiled in filling, *one-half* of the tabular numbers corresponding to the diameter of the tube will be taken. The correction for capillarity is always *added* to the observed reading of the Barometer.

CAPILLARITY.

Diameter of Tube in Inches.	Capillarity. Inches of Mercury.	Diameter of Tube. in Inches.	Capillarity. Inches of Mercury.	Diameter of Tube in Inches.	Capillarity. Inches of Mercury.	Diameter of Tube in Inches.	Capillarity. Inches of Mercury.
0·100	0·140	0·160	0·079	0·225	0·048	0·340	0·023
0·102	0·137	0·162	0·078	0·227	0·048	0·350	0·021
0·104	0·134	0·164	0·077	0·230	0·047	0·360	0·020
0·106	0·132	0·166	0·075	0·232	0·046	0·370	0·019
0·108	0·129	0·168	0·074	0·235	0·045	0·380	0·017
0·110	0·126	0·170	0·073	0·237	0·045	0·390	0·016
0·112	0·124	0·172	0·072	0·240	0·044	0·400	0·015
0·114	0·121	0·174	0·071	0·242	0·043	0·410	0·014
0·116	0·119	0·176	0·070	0·245	0·042	0·420	0·013
0·118	0·116	0·178	0·069	0·247	0·042	0·430	0·012
0·120	0·114	0·180	0·068	0·250	0·041	0·440	0·011
0·122	0·112	0·182	0·067	0·252	0·040	0·450	0·010
0·124	0·110	0·184	0·066	0·255	0·039	0·460	0·009
0·126	0·108	0·186	0·065	0·257	0·039	0·470	0·009
0·128	0·106	0·188	0·064	0·260	0·038	0·480	0·008
0·130	0·104	0·190	0·063	0·265	0·037	0·490	0·008
0·132	0·102	0·192	0·062	0·270	0·036	0·500	0·007
0·134	0·100	0·194	0·061	0·275	0·035	0·510	0·007
0·136	0·098	0·196	0·060	0·280	0·033	0·520	0·006
0·138	0·096	0·198	0·059	0·285	0·032	0·530	0·006
0·140	0·094	0·200	0·058	0·290	0·031	0·540	0·005
0·142	0·092	0·202	0·057	0·295	0·030	0·550	0·005
0·144	0·091	0·205	0·056	0·300	0·029	0·560	0·005
0·146	0·089	0·207	0·055	0·305	0·028	0·570	0·004
0·148	0·088	0·210	0·054	0·310	0·027	0·580	0·004
0·150	0·086	0·212	0·053	0·315	0·026	0·600	0·004
0·152	0·085	0·215	0·052	0·320	0·026	0·620	0·003
0·154	0·083	0·217	0·051	0·325	0·025	0·640	0·003
0·156	0·082	0·220	0·050	0·330	0·024	0·660	0·003
0·158	0·080	0·222	0·049	0·335	0·023	0·680	0·002

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TABLE II.

For reducing Observations of the Barometer to the Temperature of 32° Fahrenheit.

This Table is applicable only to Barometers with Brass Scales.

Temperature, Fahrenheit.	Reduction of the Barometer to 32° Fahrenheit. Height of the Barometer in Inches, and Correction in Decimals of an Inch.												Temperature, Fahrenheit.
	13·5	14·0	14·5	15·0	15·5	16·0	16·5	17·0	17·5	18·0	18·5	19·0	
−10°	+·047	+·049	+·050	+·052	+·054	+·056	+·057	+·059	+·061	+·062	+·064	+·066	−10°
9	·046	·047	·049	·051	·052	·054	·056	·057	·059	·061	·062	·064	9
8	·044	·046	·048	·049	·051	·053	·054	·056	·058	·059	·061	·062	8
7	·043	·045	·046	·048	·050	·051	·053	·054	·056	·058	·059	·061	7
6	·042	·043	·045	·047	·048	·050	·051	·053	·054	·056	·057	·059	6
5	·041	·042	·044	·045	·047	·048	·050	·051	·053	·054	·056	·057	5
4	·040	·041	·042	·044	·045	·047	·048	·050	·051	·053	·054	·056	4
3	·038	·040	·041	·043	·044	·045	·047	·048	·050	·051	·052	·054	3
2	·037	·038	·040	·041	·043	·044	·045	·047	·048	·049	·051	·052	2
−1	·036	·037	·039	·040	·041	·042	·044	·045	·046	·048	·049	·050	−1
0	+·035	+·036	+·037	+·038	+·040	+·041	+·042	+·044	+·045	+·046	+·047	+·049	0
+1	·033	·035	·036	·037	·038	·040	·041	·042	·043	·045	·046	·047	+1
2	·032	·033	·035	·036	·037	·038	·039	·041	·042	·043	·044	·045	2
3	·031	·032	·033	·034	·036	·037	·038	·039	·040	·041	·042	·044	3
4	·030	·031	·032	·033	·034	·035	·036	·037	·039	·040	·041	·042	4
5	·029	·030	·031	·032	·033	·034	·035	·036	·037	·038	·039	·040	5
6	·027	·028	·029	·030	·031	·032	·033	·034	·035	·036	·037	·038	6
7	·026	·027	·028	·029	·030	·031	·032	·033	·034	·035	·036	·037	7
8	·025	·026	·027	·028	·029	·029	·030	·031	·032	·033	·034	·035	8
9	·024	·025	·025	·026	·027	·028	·029	·030	·031	·032	·032	·033	9
10	·022	+·023	+·024	+·025	+·026	+·027	−·027	+·028	+·029	+·030	+·031	+·032	10
11	·021	·022	·023	·024	·024	·025	·026	·027	·028	·028	·029	·030	11
12	·020	·021	·022	·022	·023	·024	·024	·025	·026	·027	·027	·028	12
13	·019	·020	·020	·021	·022	·022	·023	·024	·024	·025	·026	·027	13
14	·018	·018	·019	·020	·020	·021	·022	·022	·023	·023	·024	·025	14
15	·016	·017	·018	·018	·019	·019	·020	·021	·021	·022	·022	·023	15
16	·015	·016	·016	·017	·017	·018	·019	·019	·020	·020	·021	·021	16
17	·014	·014	·015	·016	·016	·017	·017	·018	·018	·019	·019	·020	17
18	·013	·013	·014	·014	·015	·015	·016	·016	·017	·017	·017	·018	18
19	·012	·012	·012	·013	·013	·014	·014	·015	·015	·015	·016	·016	19

TABLE II.—For reducing Observations of the Barometer to the Temperature of 32° Fahrenheit—*continued.*

Temperature, Fahrenheit.	REDUCTION OF THE BAROMETER TO 32° FAHRENHEIT. Height of the Barometer in Inches, and Correction in Decimals of an Inch.												Temperature, Fahrenheit.
	13·5	14·0	14·5	15·0	15·5	16·0	16·5	17·0	17·5	18·0	18·5	19·0	
20°	+ ·010	+ ·011	+ ·011	+ ·011	+ ·012	+ ·012	+ ·013	+ ·013	+ ·013	+ ·014	+ ·014	+ ·015	20°
21	·009	·009	·010	·010	·010	·011	·011	·011	·012	·012	·012	·013	21
22	·008	·008	·008	·009	·009	·009	·010	·010	·010	·011	·011	·011	22
23	·007	·007	·007	·007	·008	·008	·008	·008	·009	·009	·009	·009	23
24	·005	·006	·006	·006	·006	·006	·007	·007	·007	·007	·007	·008	24
25	·004	·004	·005	·005	·005	·005	·005	·005	·006	·006	·006	·006	25
26	·003	·003	·003	·003	·003	·004	·004	·004	·004	·004	·004	·004	26
27	·002	·002	·002	·002	·002	·002	·002	·002	·002	·002	·003	·003	27
28	·001	·001	·001	·001	·001	·001	·001	·001	·001	·001	·001	·001	28
29	− ·001	− ·001	− ·001	− ·001	− ·001	− ·001	− ·001	− ·001	− ·001	− ·001	− ·001	− ·001	29
30	− ·002	− ·002	− ·002	− ·002	− ·002	− ·002	− ·002	− ·002	− ·002	− ·002	− ·002	− ·003	30
31	·003	·003	·003	·003	·003	·004	·003	·004	·004	·004	·004	·004	31
32	·004	·004	·005	·005	·005	·005	·005	·005	·005	·006	·006	·006	32
33	·005	·006	·006	·006	·006	·006	·007	·007	·007	·007	·007	·008	33
34	·007	·007	·007	·007	·008	·008	·008	·008	·009	·009	·009	·009	34
35	·008	·008	·008	·009	·009	·009	·010	·010	·010	·010	·011	·011	35
36	·009	·009	·010	·010	·010	·011	·011	·011	·012	·012	·012	·013	36
37	·010	·011	·011	·011	·012	·012	·013	·013	·013	·014	·014	·014	37
38	·011	·012	·012	·013	·013	·014	·014	·014	·015	·015	·016	·016	38
39	·013	·013	·014	·014	·015	·015	·016	·016	·016	·017	·017	·018	39
40	− ·014	− ·014	− ·015	− ·015	− ·016	− ·016	− ·017	− ·018	− ·018	− ·019	− ·019	− ·020	40
41	·015	·016	·016	·017	·017	·018	·018	·019	·020	·020	·021	·021	41
42	·016	·017	·018	·018	·019	·019	·020	·021	·021	·022	·022	·023	42
43	·018	·018	·019	·019	·020	·021	·021	·022	·023	·023	·024	·025	43
44	·019	·019	·020	·021	·022	·022	·023	·024	·024	·025	·026	·026	44
45	·020	·021	·021	·022	·023	·024	·024	·025	·026	·027	·027	·028	45
46	·021	·022	·023	·023	·024	·025	·026	·027	·027	·028	·029	·030	46
47	·022	·023	·024	·025	·026	·026	·027	·028	·029	·030	·031	·031	47
48	·024	·024	·025	·026	·027	·028	·029	·030	·031	·031	·032	·033	48
49	·025	·026	·027	·028	·028	·029	·030	·031	·032	·033	·034	·035	49

Table II.—For reducing Observations of the Barometer to the Temperature of 32° Fahrenheit—*continued*.

Temperature, Fahrenheit.	Reduction of the Barometer to 32° Fahrenheit. Height of the Barometer in Inches, and Correction in Decimals of an Inch.												Temperature, Fahrenheit.
	13·5	14·0	14·5	15·0	15·5	16·0	16·5	17·0	17·5	18·0	18·5	19·0	
50°	— ·026	— ·027	— ·028	— ·029	— ·030	— ·031	— ·032	— ·033	— ·034	— ·035	— ·036	— ·037	50°
51	·027	·028	·029	·030	·031	·032	·033	·034	·035	·036	·037	·038	51
52	·028	·029	·030	·032	·033	·034	·035	·036	·037	·038	·039	·040	52
53	·030	·031	·032	·033	·034	·035	·036	·037	·038	·039	·041	·042	53
54	·031	·032	·033	·034	·035	·036	·038	·039	·040	·041	·042	·043	54
55	·032	·033	·034	·036	·037	·038	·039	·040	·041	·043	·044	·045	55
56	·033	·034	·036	·037	·038	·039	·041	·042	·043	·044	·046	·047	56
57	·034	·036	·037	·038	·040	·041	·042	·043	·045	·046	·047	·048	57
58	·036	·037	·038	·040	·041	·042	·044	·045	·046	·047	·049	·050	58
59	·037	·038	·040	·041	·042	·044	·045	·046	·048	·049	·050	·052	59
60	— ·038	— ·039	— ·041	— ·042	— ·044	— ·045	— ·047	— ·048	— ·049	— ·051	— ·052	— ·054	60
61	·039	·041	·042	·044	·045	·046	·048	·049	·051	·052	·054	·055	61
62	·040	·042	·043	·045	·046	·048	·049	·051	·052	·054	·055	·057	62
63	·042	·043	·045	·046	·048	·049	·051	·052	·054	·055	·057	·059	63
64	·043	·044	·046	·048	·049	·051	·052	·054	·056	·057	·059	·060	64
65	·044	·046	·047	·049	·051	·052	·054	·055	·057	·059	·060	·062	65
66	·045	·047	·049	·050	·052	·054	·055	·057	·059	·060	·062	·064	66
67	·046	·048	·050	·052	·053	·055	·057	·058	·060	·062	·064	·065	67
68	·048	·049	·051	·053	·055	·056	·058	·060	·062	·064	·065	·067	68
69	·049	·051	·052	·054	·056	·058	·060	·062	·063	·065	·067	·069	69
70	— ·050	— ·052	— ·054	— ·056	— ·057	— ·059	— ·061	— ·063	— ·065	— ·067	— ·069	— ·070	70
71	·051	·053	·055	·057	·059	·061	·062	·065	·066	·068	·070	·072	71
72	·052	·054	·056	·058	·060	·062	·064	·066	·068	·070	·072	·074	72
73	·054	·056	·058	·060	·062	·064	·066	·068	·070	·072	·074	·076	73
74	·055	·057	·059	·061	·063	·065	·067	·069	·071	·073	·075	·077	74
75	·056	·058	·060	·062	·064	·066	·068	·071	·073	·075	·077	·079	75
76	·057	·059	·062	·064	·066	·068	·070	·072	·074	·076	·078	·081	76
77	·058	·061	·063	·065	·067	·069	·071	·074	·076	·078	·080	·082	77
78	·060	·062	·064	·066	·068	·071	·073	·075	·077	·080	·082	·084	78
79	·061	·063	·065	·068	·070	·072	·074	·077	·079	·081	·083	·086	79

TABLE II.—For reducing Observations of the Barometer to the Temperature of 32° Fahrenheit—*continued*.

Temperature, Fahrenheit.	REDUCTION OF THE BAROMETER TO 32° FAHRENHEIT. Height of the Barometer in Inches, and Correction in Decimals of an Inch.												Temperature, Fahrenheit.
	13·5	14·0	14·5	15·0	15·5	16·0	16·5	17·0	17·5	18·0	18·5	19·0	
° 80	—·062	—·064	—·067	—·069	—·071	—·074	—·076	—·078	—·080	—·083	—·085	—·087	° 80
81	·063	·066	·068	·070	·073	·075	·077	·080	·082	·084	·087	·089	81
82	·064	·067	·069	·072	·074	·076	·079	·081	·084	·086	·088	·091	82
83	·066	·068	·070	·073	·075	·078	·080	·083	·085	·088	·090	·092	83
84	·067	·069	·072	·074	·077	·079	·082	·084	·087	·089	·092	·094	84
85	·068	·071	·073	·076	·078	·081	·083	·086	·088	·091	·093	·096	85
86	·069	·072	·074	·077	·079	·082	·085	·087	·090	·092	·095	·097	86
87	·070	·073	·076	·078	·081	·083	·086	·089	·091	·094	·097	·099	87
88	·072	·074	·077	·080	·082	·085	·088	·090	·093	·095	·098	·101	88
89	·073	·076	·078	·081	·084	·086	·089	·092	·094	·097	·100	·103	89
90	—·074	—·077	—·079	—·082	·085	—·088	—·090	—·093	—·096	—·099	—·101	—·104	90
91	·075	·078	·081	·084	·086	·089	·092	·095	·097	·100	·103	·106	91
92	·076	·079	·082	·085	·088	·091	·093	·096	·099	·102	·105	·108	92
93	·078	·080	·083	·086	·089	·092	·095	·098	·101	·103	·106	·109	93
94	·079	·082	·085	·088	·090	·093	·096	·099	·102	·105	·108	·111	94
95	·080	·083	·086	·089	·092	·095	·098	·101	·104	·107	·110	·113	95
96	·081	·084	·087	·090	·093	·096	·099	·102	·105	·108	·111	·114	96
97	·082	·085	·088	·092	·095	·098	·101	·104	·107	·110	·113	·116	97
98	·084	·087	·090	·093	·096	·099	·102	·105	·108	·111	·115	·118	98
99	·085	·088	·091	·094	·097	·100	·104	·107	·110	·113	·116	·119	99
100	—·086	—·089	—·092	—·096	—·099	—·102	—·105	—·108	—·111	—·115	—·118	—·121	100
101	·087	·090	·094	·097	·100	·103	·107	·110	·113	·116	·119	·123	101
102	·088	·092	·095	·098	·101	·105	·108	·111	·115	·118	·121	·124	102
103	·090	·093	·096	·099	·103	·106	·109	·113	·116	·119	·123	·126	103
104	·091	·094	·097	·101	·104	·108	·111	·114	·118	·121	·124	·128	104
105	·092	·095	·099	·102	·106	·109	·112	·116	·119	·123	·126	·129	105
106	·093	·097	·100	·103	·107	·110	·114	·117	·121	·124	·128	·131	106
107	·094	·098	·101	·105	·108	·112	·115	·119	·122	·126	·129	·133	107
108	·096	·099	·103	·106	·110	·113	·117	·120	·124	·127	·131	·134	108
109	·097	·100	·104	·107	·111	·115	·118	·122	·125	·129	·132	·136	109
110	·098	·102	·105	·109	·112	·116	·120	·123	·127	·130	·134	·138	110

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TABLE II.—For reducing Observations of the Barometer to the Temperature of 32° Fahrenheit—*continued.*

Temperature, Fahrenheit.	Reduction of the Barometer to 32° Fahrenheit. Height of the Barometer in Inches, and Correction in Decimals of an Inch.												Temperature, Fahrenheit.
	19·5	20·0	20·5	21·0	21·5	22·0	22·5	23·0	23·5	24·0	24·5	25·0	
−10°	+·068	+·069	+·071	+·073	+·075	+·076	+·078	+·080	+·082	+·083	+·085	+·087	−10°
9	·066	·068	·069	·071	·073	·074	·076	·078	·079	·081	·083	·084	9
8	·064	·066	·067	·069	·071	·072	·074	·076	·077	·079	·081	·082	8
7	·062	·064	·066	·067	·069	·070	·072	·074	·075	·077	·078	·080	7
6	·061	·062	·064	·065	·067	·068	·070	·071	·073	·075	·076	·078	6
5	·059	·060	·062	·063	·064	·066	·068	·069	·071	·072	·074	·075	5
4	·057	·059	·060	·061	·063	·064	·066	·067	·069	·070	·072	·073	4
3	·055	·057	·058	·060	·060	·062	·064	·065	·067	·068	·069	·071	3
2	·054	·055	·056	·058	·058	·060	·062	·063	·064	·066	·067	·069	2
−1	·052	·053	·054	·056	·057	·058	·060	·061	·062	·064	·065	·066	−1
0	+·050	+·051	+·053	+·054	+ 055	+·056	+·058	+·059	+·060	+·061	+·063	+·064	0
+1	·048	·049	·051	·052	·053	·054	·056	·057	·058	·059	·061	·062	+1
2	·046	·048	·049	·050	·051	·052	·054	·055	·056	·057	·058	·060	2
3	·045	·046	·047	·048	·049	·050	·052	·053	·054	·055	·056	·057	3
4	·043	·044	·045	·046	·047	·048	·050	·051	·052	·053	·054	·055	4
5	·041	·042	·043	·044	·045	·046	·048	·049	·050	·051	·052	·053	5
6	·039	·040	·042	·042	·044	·044	·046	·047	·048	·049	·050	·051	6
7	·038	·039	·040	·041	·042	·042	·044	·044	·046	·046	·047	·048	7
8	·036	·037	·038	·039	·040	·041	·041	·042	·043	·044	·045	·046	8
9	·034	·035	·036	·037	·038	·039	·039	·040	·041	·042	·043	·044	9
10	+·032	+·033	+·034	+·035	+·036	+·037	+·037	+·038	+·039	+·040	+·041	+·042	10
11	·031	·031	·032	·033	·034	·035	·035	·036	·037	·038	·039	·039	11
12	·029	·030	·030	·031	·032	·033	·033	·034	·035	·036	·036	·037	12
13	·027	·028	·029	·029	·030	·031	·031	·032	·033	·033	·034	·035	13
14	·025	·026	·027	·027	·028	·029	·029	·030	·031	·031	·032	·033	14
15	·024	·024	·025	·026	·026	·027	·027	·028	·029	·029	·030	·030	15
16	·022	·022	·023	·024	·024	·025	·025	·026	·026	·027	·028	·028	16
17	·020	·021	·021	·022	·022	·023	·023	·024	·024	·025	·025	·026	17
18	·018	·019	·019	·020	·020	·021	·021	·022	·022	·023	·023	·024	18
19	·017	·017	·018	·018	·018	·019	·019	·020	·020	·021	·021	·021	19

TABLE II.—For reducing Observations of the Barometer to the Temperature of 32° Fahrenheit—*continued*.

Temperature, Fahrenheit.	REDUCTION OF THE BAROMETER TO 32° FAHRENHEIT. Height of the Barometer in Inches, and Correction in Decimals of an Inch.												Temperature, Fahrenheit.
	19·5	20·0	20·5	21·0	21·5	22·0	22·5	23·0	23·5	24·0	24·5	25·0	
20°	+·015	+·015	+·016	+·016	+·016	+·017	+·017	+·018	+·018	+·018	+·019	+·019	20°
21	·013	·014	·014	·014	·015	·015	·015	·015	·016	·016	·017	·017	21
22	·011	·012	·012	·012	·013	·013	·013	·013	·014	·014	·014	·015	22
23	·010	·010	·010	·010	·011	·011	·011	·011	·012	·012	·012	·012	23
24	·008	·008	·008	·009	·009	·009	·009	·009	·010	·010	·010	·010	24
25	·006	·006	·007	·007	·007	·007	·007	·007	·007	·008	·008	·008	25
26	·004	·005	·005	·005	·005	·005	·005	·005	·005	·005	·006	·006	26
27	·003	·003	·003	·003	·003	·003	·003	·003	·003	·003	·003	·003	27
28	·001	·001	·001	·001	·001	·001	·001	·001	·001	·001	·001	·001	28
29	−·001	−·001	−·001	−·001	−·001	−·001	−·001	−·001	−·001	−·001	−·001	−·001	29
30	−·003	−·003	−·003	−·003	−·003	−·003	−·003	−·003	−·003	−·003	−·003	−·003	30
31	·004	·005	·005	·005	·005	·005	·005	·005	·005	·005	·006	·006	31
32	·006	·006	·006	·007	·007	·007	·007	·007	·007	·008	·008	·008	32
33	·008	·008	·008	·008	·009	·009	·009	·009	·010	·010	·010	·010	33
34	·010	·010	·010	·010	·011	·011	·011	·011	·012	·012	·012	·012	34
35	·011	·012	·012	·012	·013	·013	·013	·013	·014	·014	·014	·015	35
36	·013	·013	·014	·014	·014	·015	·015	·016	·016	·016	·017	·017	36
37	·015	·015	·016	·016	·016	·017	·017	·018	·018	·018	·019	·019	37
38	·017	·017	·017	·018	·018	·019	·019	·020	·020	·020	·021	·021	38
39	·018	·019	·019	·020	·020	·021	·021	·022	·022	·023	·023	·024	39
40	−·020	−·021	−·021	−·022	−·022	−·023	−·023	−·024	−·024	−·025	−·025	−·026	40
41	·022	·022	·023	·024	·024	·025	·025	·026	·026	·027	·027	·028	41
42	·024	·024	·025	·025	·026	·027	·027	·028	·028	·029	·030	·030	42
43	·025	·026	·027	·027	·028	·029	·029	·030	·031	·031	·032	·032	43
44	·027	·028	·029	·029	·030	·031	·031	·032	·033	·033	·034	·035	44
45	·029	·030	·030	·031	·032	·033	·033	·034	·035	·035	·036	·037	45
46	·031	·031	·032	·033	·034	·035	·035	·036	·037	·038	·038	·039	46
47	·032	·033	·034	·035	·036	·036	·037	·038	·039	·040	·041	·041	47
48	·034	·035	·036	·037	·038	·038	·039	·040	·041	·042	·043	·044	48
49	·036	·037	·038	·039	·040	·040	·041	·042	·043	·044	·045	·046	49

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TABLE II.—For reducing Observations of the Barometer to the Temperature of 32° Fahrenheit—*continued.*

Temperature, Fahrenheit.	Reduction of the Barometer to 32° Fahrenheit.												Temperature, Fahrenheit.
	Height of the Barometer in Inches, and Correction in Decimals of an Inch.												
	19·5	20·0	20·5	21·0	21·5	22·0	22·5	23·0	23·5	24·0	24·5	25·0	
50°	−·037	−·038	−·039	−·040	−·041	−·042	−·043	−·044	−·045	−·046	−·047	−·048	50°
51	·039	·040	·041	·042	·043	·044	·045	·046	·047	·048	·049	·050	51
52	·041	·042	·043	·044	·045	·046	·047	·048	·049	·050	·052	·053	52
53	·043	·044	·045	·046	·047	·048	·049	·050	·052	·053	·054	·055	53
54	·044	·046	·047	·048	·049	·050	·051	·052	·054	·055	·056	·057	54
55	·046	·047	·049	·050	·051	·052	·053	·055	·056	·057	·058	·059	55
56	·048	·049	·050	·052	·053	·054	·055	·057	·058	·059	·060	·061	56
57	·050	·051	·052	·054	·055	·056	·057	·059	·060	·061	·062	·064	57
58	·051	·053	·054	·055	·057	·058	·059	·061	·062	·063	·065	·066	58
59	·053	·055	·056	·057	·059	·060	·061	·063	·064	·065	·067	·068	59
60	−·055	−·056	−·058	−·059	−·061	−·062	−·063	−·065	−·066	−·068	−·069	−·070	60
61	·057	·058	·060	·061	·062	·064	·065	·067	·068	·070	·071	·073	61
62	·058	·060	·061	·063	·064	·066	·067	·069	·070	·072	·073	·075	62
63	·060	·062	·063	·065	·066	·068	·069	·071	·072	·074	·076	·077	63
64	·062	·063	·065	·067	·068	·070	·071	·073	·075	·076	·078	·079	64
65	·064	·065	·067	·068	·070	·072	·073	·075	·077	·078	·080	·082	65
66	·065	·067	·069	·070	·072	·074	·075	·077	·079	·080	·082	·084	66
67	·067	·069	·071	·072	·074	·076	·077	·079	·081	·083	·084	·086	67
68	·069	·071	·072	·074	·076	·078	·079	·081	·083	·085	·086	·088	68
69	·071	·072	·074	·076	·078	·080	·081	·083	·085	·087	·089	·090	69
70	−·072	−·074	−·076	−·078	−·080	−·082	−·083	−·085	−·087	−·089	−·091	−·093	70
71	·074	·076	·078	·080	·082	·083	·085	·087	·089	·091	·093	·095	71
72	·076	·078	·080	·082	·084	·085	·087	·089	·091	·093	·095	·097	72
73	·078	·079	·081	·083	·085	·087	·089	·091	·093	·095	·097	·099	73
74	·079	·081	·083	·085	·087	·089	·091	·093	·095	·098	·099	·102	74
75	·081	·083	·085	·087	·089	·091	·093	·095	·098	·100	·102	·104	75
76	·083	·085	·087	·089	·091	·093	·095	·097	·100	·102	·104	·106	76
77	·084	·087	·089	·091	·093	·095	·097	·100	·102	·104	·106	·108	77
78	·086	·088	·091	·093	·095	·097	·099	·102	·104	·106	·108	·110	78
79	·088	·090	·092	·095	·097	·099	·101	·104	·106	·108	·110	·113	79

TABLE II.—For reducing Observations of the Barometer to the Temperature of 32° Fahrenheit—*continued*.

Temperature, Fahrenheit.	REDUCTION OF THE BAROMETER TO 32° FAHRENHEIT. Height of Barometer in Inches, and Correction in Decimals of an Inch.												Temperature, Fahrenheit.
	19·5	20·0	20·5	21·0	21·5	22·0	22·5	23·0	23·5	24·0	24·5	25·0	
80°	−·090	−·092	−·094	−·096	−·099	−·101	−·103	−·106	−·108	−·110	−·113	−·115	80°
81	·091	·094	·096	·098	·101	·103	·105	·108	·110	·112	·115	·117	81
82	·093	·095	·098	·100	·103	·105	·107	·110	·112	·114	·117	·119	82
83	·095	·097	·100	·102	·104	·107	·109	·112	·114	·117	·119	·121	83
84	·097	·099	·101	·104	·106	·109	·111	·114	·116	·119	·121	·124	84
85	·098	·101	·103	·106	·108	·111	·113	·116	·118	·121	·123	·126	85
86	·100	·102	·105	·108	·110	·114	·115	·118	·120	·123	·126	·128	86
87	·102	·104	·107	·109	·112	·115	·117	·120	·123	·125	·128	·130	87
88	·103	·106	·109	·111	·114	·117	·119	·122	·125	·127	·130	·133	88
89	·105	·108	·111	·113	·116	·119	·121	·124	·127	·129	·132	·135	89
90	−·107	−·109	−·112	−·115	−·118	−·121	−·123	−·126	−·129	−·131	−·134	−·137	90
91	·109	·111	·114	·117	·120	·122	·125	·128	·131	·134	·136	·139	91
92	·110	·113	·116	·119	·122	·125	·127	·130	·133	·136	·139	·141	92
93	·112	·115	·118	·121	·124	·126	·129	·132	·135	·138	·141	·144	93
94	·114	·117	·120	·122	·125	·128	·131	·134	·137	·140	·143	·146	94
95	·116	·118	·121	·124	·127	·130	·133	·136	·139	·142	·145	·148	95
96	·117	·120	·123	·126	·129	·132	·135	·138	·141	·144	·147	·150	96
97	·119	·122	·125	·128	·131	·134	·137	·140	·143	·146	·149	·152	97
98	·121	·124	·127	·130	·133	·136	·139	·142	·145	·148	·152	·155	98
99	·122	·125	·129	·132	·135	·138	·141	·144	·147	·151	·154	·157	99
100	−·124	−·127	−·131	−·134	−·137	−·140	−·143	−·146	−·150	−·153	−·156	−·159	100
101	·126	·129	·132	·136	·139	·142	·145	·148	·152	·155	·158	·161	101
102	·128	·131	·134	·137	·141	·144	·147	·151	·154	·157	·160	·164	102
103	·129	·133	·136	·139	·143	·146	·149	·153	·156	·159	·163	·166	103
104	·131	·134	·138	·141	·144	·148	·151	·155	·158	·161	·165	·168	104
105	·133	·136	·140	·143	·146	·150	·153	·157	·160	·163	·167	·170	105
106	·135	·138	·141	·145	·148	·152	·155	·159	·162	·166	·169	·172	106
107	·136	·140	·143	·147	·150	·154	·157	·161	·164	·168	·171	·175	107
108	·138	·141	·145	·149	·152	·156	·159	·163	·166	·170	·173	·177	108
109	·140	·143	·147	·150	·154	·158	·161	·165	·168	·172	·175	·179	109
110	·141	·145	·149	·152	·156	·159	·163	·167	·170	·174	·178	·181	110

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TABLE II.—For reducing Observations of the Barometer to the Temperature of 32° Fahrenheit—*continued.*

Temperature, Fahrenheit.	Reduction of the Barometer to 32° Fahrenheit. Height of the Barometer in Inches, and Correction in Decimals of an Inch.											Temperature, Fahrenheit.
	25·5	26·0	26·5	27·0	27·5	28·0	28·5	29·0	29·5	30·0	30·5	31·0	
−10°	+·088	+·090	+·092	+·094	+·095	+·097	+·099	+·101	+·102	+·104	+·106	+·108	−10°
9	·086	·088	·090	·091	·093	·095	·096	·098	·100	·101	·103	·105	9
8	·084	·085	·087	·089	·090	·092	·094	·095	·097	·099	·100	·102	8
7	·082	·083	·085	·086	·088	·090	·091	·093	·094	·096	·098	·099	7
6	·079	·081	·082	·084	·085	·087	·089	·090	·092	·093	·095	·096	6
5	·077	·078	·080	·081	·083	·084	·086	·087	·089	·090	·092	·094	5
4	·075	·076	·078	·079	·080	·082	·083	·085	·086	·088	·089	·091	4
3	·072	·074	·075	·077	·078	·079	·081	·082	·084	·085	·087	·088	3
2	·070	·071	·073	·074	·076	·077	·078	·080	·081	·082	·084	·085	2
−1	·068	·069	·070	·072	·073	·074	·076	·077	·078	·080	·081	·082	−1
0	+·065	+·067	+·068	+·069	+·071	+·072	+·073	+·074	+·076	+·077	+·078	+·080	0
+1	·063	·064	·065	·067	·068	·069	·071	·072	·073	·074	·076	·077	+1
2	·061	·062	·063	·064	·066	·067	·068	·069	·070	·072	·073	·074	2
3	·059	·060	·061	·062	·063	·064	·065	·067	·068	·069	·070	·071	3
4	·056	·057	·058	·059	·061	·062	·063	·064	·065	·066	·067	·068	4
5	·054	·055	·056	·057	·058	·059	·060	·061	·062	·063	·065	·066	5
6	·052	·053	·054	·055	·056	·057	·058	·059	·060	·061	·062	·063	6
7	·049	·050	·051	·052	·053	·054	·055	·056	·057	·058	·059	·060	7
8	·047	·048	·049	·050	·051	·052	·053	·054	·054	·055	·056	·057	8
9	·045	·046	·046	·047	·048	·049	·050	·051	·052	·053	·054	·054	9
10	+·042	+·043	+·044	+·045	+·046	+·047	+·047	+·048	+·049	+·050	+·051	+·052	10
11	·040	·041	·042	·042	·043	·044	·045	·046	·046	·047	·048	·049	11
12	·038	·039	·039	·040	·041	·042	·042	·043	·044	·045	·045	·046	12
13	·036	·036	·037	·038	·038	·039	·040	·040	·041	·042	·043	·043	13
14	·033	·034	·035	·035	·036	·037	·037	·038	·038	·039	·040	·040	14
15	·031	·032	·032	·033	·033	·034	·035	·035	·036	·036	·037	·038	15
16	·029	·029	·030	·030	·031	·032	·032	·033	·033	·034	·034	·035	16
17	·026	·027	·027	·028	·028	·029	·030	·030	·031	·031	·032	·032	17
18	·024	·025	·025	·025	·026	·026	·027	·027	·028	·028	·029	·029	18
19	·022	·022	·023	·023	·024	·024	·024	·025	·025	·026	·026	·027	19

Table II.—For reducing Observations of the Barometer to the Temperature of 32° Fahrenheit—*continued.*

Temperature, Fahrenheit.	Reduction of the Barometer to 32° Fahrenheit. Height of the Barometer in Inches, and Correction in Decimals of an Inch.												Temperature, Fahrenheit.
	25·5	26·0	26·5	27·0	27·5	28·0	28·5	29·0	29·5	30·0	30·5	31·0	
20°	+·020	+·020	+·020	+·021	+·021	+·021	+·022	·022	+·023	+·023	+·023	+·024	20°
21	·017	·013	·018	·018	·019	·019	·019	·020	·020	·020	·021	·021	21
22	·015	·015	·016	·016	·016	·016	·017	·017	·017	·018	·018	·018	22
23	·013	·013	·013	·013	·014	·014	·014	·014	·015	·015	·015	·015	23
24	·010	·011	·011	·011	·011	·011	·012	·012	·012	·012	·012	·013	24
25	·008	·008	·008	·009	·009	·009	·009	·009	·009	·009	·010	·010	25
26	·006	·006	·006	·006	·006	·006	·006	·007	·007	·007	·007	·007	26
27	·003	·004	·004	·004	·004	·004	·004	·004	·004	·004	·004	·004	27
28	·001	·001	·001	·001	·001	·001	·001	·001	·001	·001	·001	·001	28
29	−·001	−·001	−·001	−·001	−·001	−·001	−·001	−·001	−·001	−·001	−·001	−·001	29
30	−·004	−·004	−·004	−·004	−·004	−·004	−·004	−·004	−·004	−·004	−·004	−·004	30
31	·006	·006	·006	·006	·006	·006	·006	·007	·007	·007	·007	·007	31
32	·008	·008	·008	·008	·009	·009	·009	·009	·009	·009	·010	·010	32
33	·010	·011	·011	·011	·011	·011	·012	·012	·012	·012	·012	·012	33
34	·013	·013	·013	·013	·014	·014	·014	·014	·015	·015	·015	·015	34
35	·015	·015	·015	·016	·016	·016	·017	·017	·017	·018	·018	·018	35
36	·017	·017	·018	·018	·019	·019	·019	·019	·020	·020	·021	·021	36
37	·019	·020	·020	·021	·021	·021	·022	·022	·022	·023	·023	·024	37
38	·022	·022	·023	·023	·023	·024	·024	·025	·025	·026	·026	·026	38
39	·024	·024	·025	·025	·026	·026	·027	·027	·028	·028	·029	·029	39
40	−·026	−·027	−·027	−·028	−·028	−·029	−·029	−·030	−·030	−·031	−·031	−·032	40
41	·029	·029	·030	·030	·031	·031	·032	·033	·033	·034	·034	·035	41
42	·031	·031	·032	·033	·033	·034	·034	·035	·036	·036	·037	·037	42
43	·033	·034	·034	·035	·036	·036	·037	·038	·038	·039	·040	·040	43
44	·035	·036	·037	·037	·038	·039	·040	·040	·041	·042	·042	·043	44
45	·038	·038	·039	·040	·041	·041	·042	·043	·043	·044	·045	·046	45
46	·040	·041	·042	·042	·043	·044	·045	·045	·046	·047	·048	·049	46
47	·042	·043	·044	·045	·046	·046	·047	·048	·049	·050	·051	·051	47
48	·045	·045	·046	·047	·048	·049	·050	·051	·052	·052	·053	·054	48
49	·047	·048	·049	·050	·050	·051	·052	·053	·054	·055	·056	·057	49

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TABLE II.—For reducing Observations of the Barometer to the Temperature of 32° Fahrenheit—*continued.*

Temperature, Fahrenheit.	REDUCTION OF THE BAROMETER TO 32° FAHRENHEIT. Height of the Barometer in Inches, and Correction in Decimals of an Inch.												Temperature, Fahrenheit.
	25·5	26·0	26·5	27·0	27·5	28·0	28·5	29·0	29·5	30·0	30·5	31·0	
50°	– ·049	– ·050	– ·051	– ·052	– ·053	– ·054	– ·055	– ·056	– ·057	– ·058	– ·059	– ·060	50°
51	·051	·052	·053	·054	·055	·056	·057	·058	·059	·060	·061	·062	51
52	·054	·055	·056	·057	·058	·059	·060	·061	·062	·063	·064	·065	52
53	·056	·057	·058	·059	·060	·061	·063	·064	·065	·066	·067	·068	53
54	·058	·059	·060	·062	·063	·064	·065	·066	·067	·068	·070	·071	54
55	·060	·062	·063	·064	·065	·066	·068	·069	·070	·071	·072	·073	55
56	·063	·064	·065	·066	·068	·069	·070	·071	·073	·074	·075	·076	56
57	·065	·066	·068	·069	·070	·071	·073	·074	·075	·076	·078	·079	57
58	·067	·069	·070	·071	·073	·074	·075	·077	·078	·079	·081	·082	58
59	·070	·071	·072	·074	·075	·076	·078	·079	·080	·082	·083	·085	59
60	– ·072	– ·073	– ·075	– ·076	– ·077	– ·079	– ·080	– ·082	– ·083	– ·085	– ·086	– ·087	60
61	·074	·075	·077	·078	·080	·081	·083	·084	·086	·087	·089	·090	61
62	·076	·078	·079	·081	·082	·084	·085	·087	·088	·090	·091	·093	62
63	·079	·080	·082	·083	·085	·086	·088	·089	·091	·093	·094	·096	63
64	·081	·082	·084	·086	·087	·089	·090	·092	·094	·095	·097	·098	64
65	·083	·085	·086	·088	·090	·091	·093	·095	·096	·098	·100	·101	65
66	·085	·087	·089	·090	·092	·094	·096	·097	·099	·101	·102	·104	66
67	·088	·089	·091	·093	·095	·096	·098	·100	·102	·103	·105	·107	67
68	·090	·092	·094	·095	·097	·099	·101	·102	·104	·106	·108	·109	68
69	·092	·094	·096	·098	·100	·101	·103	·105	·107	·109	·110	·112	69
70	– ·095	– ·096	– ·098	– ·100	– ·102	– ·104	– ·106	– ·108	– ·109	– ·111	– ·113	– ·115	70
71	·097	·099	·101	·102	·104	·106	·108	·110	·112	·114	·116	·118	71
72	·099	·101	·103	·105	·107	·109	·111	·113	·115	·117	·119	·120	72
73	·101	·103	·105	·107	·109	·111	·113	·115	·117	·119	·121	·123	73
74	·104	·106	·108	·110	·112	·114	·116	·118	·120	·122	·124	·126	74
75	·106	·108	·110	·112	·114	·116	·118	·120	·122	·125	·127	·129	75
76	·108	·110	·112	·114	·117	·119	·121	·123	·125	·127	·129	·131	76
77	·110	·112	·115	·117	·119	·121	·123	·126	·128	·130	·132	·134	77
78	·113	·115	·117	·119	·122	·124	·126	·128	130	·133	·135	·137	78
79	·115	·117	·119	·122	·124	·126	·128	·131	·133	·135	·137	·140	79

TABLE II.—For reducing Observations of the Barometer to the Temperature of 32° Fahrenheit—*continued.*

Temperature, Fahrenheit.	REDUCTION OF THE BAROMETER TO 32° FAHRENHEIT. Height of the Barometer in Inches, and Correction in Decimals of an Inch.												Temperature, Fahrenheit.
	25·5	26·0	26·5	27·0	27·5	28·0	28·5	29·0	29·5	30·0	30·5	31·0	
80°	−·117	−·119	−·122	−·124	−·126	−·129	−·131	−·133	−·136	−·138	−·140	−·143	80°
81	·119	·122	·124	·126	·129	·131	·134	·136	·138	·141	·143	·145	81
82	·122	·124	·126	·129	·131	·134	·136	·138	·141	·143	·146	·148	82
83	·124	·126	·129	·131	·134	·136	·139	·141	·143	·146	·148	·151	83
84	·126	·129	·131	·134	·136	·139	·141	·144	·146	·149	·151	·154	84
85	·128	·131	·133	·136	·139	·141	·144	·146	·149	·151	·154	·156	85
86	·131	·133	·136	·138	·141	·144	·146	·149	·151	·154	·156	·159	86
87	·133	·136	·138	·141	·143	·146	·149	·151	·154	·157	·159	·162	87
88	·135	·138	·141	·143	·146	·149	·151	·154	·157	·159	·162	·165	88
89	·137	·140	·143	·145	·148	·151	·154	·156	·159	·162	·165	·167	89
90	−·140	−·142	−·145	−·148	−·151	−·153	−·156	−·159	−·162	−·164	−·167	−·170	90
91	·142	·145	·148	·150	·153	·156	·159	·162	·165	·167	·170	·173	91
92	·144	·147	·150	·153	·156	·158	·161	·164	·167	·170	·172	·175	92
93	·147	·149	·152	·155	·158	·161	·164	·167	·170	·172	·175	·178	93
94	·149	·152	·155	·157	·161	·163	·166	·169	·172	·175	·177	·180	94
95	·151	·154	·157	·160	·163	·166	·169	·172	·175	·178	·180	·183	95
96	·153	·156	·159	·162	·165	·168	·171	·174	·178	·181	·183	·186	96
97	·156	·159	·162	·165	·168	·171	·174	·177	·180	·183	·186	·189	97
98	·158	·161	·164	·167	·170	·173	·176	·179	·183	·186	·188	·191	98
99	·160	·163	·166	·169	·173	·176	·179	·182	·185	·188	·191	·194	99
100	−·162	−·166	−·169	−·172	−·175	−·178	−·181	−·185	−·188	−·191	−·194	−·197	100
101	·165	·168	·171	·174	·178	·181	·184	·187	·190	·194	·197	·200	101
102	·167	·170	·173	·177	·180	·183	·186	·190	·193	·196	·200	·203	102
103	·169	·172	·176	·179	·182	·186	·189	·192	·196	·199	·202	·206	103
104	·171	·175	·178	·181	·185	·188	·192	·195	·198	·202	·205	·208	104
105	·174	·177	·180	·184	·187	·191	·194	·197	·201	·204	·208	·211	105
106	·176	·179	·183	·186	·190	·193	·197	·200	·203	·207	·210	·214	106
107	·178	·182	·185	·189	·192	·196	·199	·203	·206	·210	·213	·217	107
108	·180	·184	·187	·191	·195	·198	·202	·205	·209	·212	·216	·219	108
109	·183	·186	·190	·193	·197	·201	·204	·208	·211	·215	·218	·222	109
110	·185	·189	·192	·196	·199	·203	·207	·210	·214	·218	·221	·225	110

This table has been extended so as to include ranges of temperature from −10° to 0°, and from 100° to 110° Fahr. and for inches below 20, by means of the formula (h being the reading of the barometer and t the temperature) :—

$$\text{Reduction} = h\,\frac{0{\cdot}0001001\,(t-32) - 0{\cdot}00001043\,(t-62)}{1 + 0{\cdot}0001001\,(t-32)}$$

which is the formula used by Schumacher in the construction of the original table. See *Sammlung von Hülfstafeln*, p. 187, *New Ed.*; *Altona*, 1845.

TABLE III.

A CONCISE TABLE FOR THE APPROXIMATE DETERMINATION OF HEIGHTS FROM BAROMETRICAL OBSERVATIONS.

PART I.

Inches.	Argument.—Mean Reading of Barometers. Tenths.										Proportional Parts for Hundredths, *Subtract.*			
	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9	·02	·04	·06	·08
25	1004·9	999·9	995·0	990·1	985·3	980·5	975·8	971·1	966·5	961·9	1·0	1·9	2·9	3·8
26	957·4	952·9	948·4	944·0	939·7	935·4	931·1	926·9	922·8	918·6	0·9	1·7	2·6	3·4
27	914·5	910·5	906·5	902·5	898·6	894·7	890·8	887·0	883·3	879·5	0·8	1·5	2·3	3·1
28	875·8	872·1	868·5	864·9	861·3	857·8	854·3	850·8	847·4	844·0	0·7	1·4	2·1	2·8
29	840·6	837·2	833·9	830·6	827·3	824·1	820·9	817·7	814·5	811·4	0·6	1·3	1·9	2·6
30	808·3	805·2	802·1	799·0	796·0	793·0	790·0	787·0	784·1	781·2	0·6	1·2	1·8	2·4

PART II.

Difference of Attached Thermometers.	Mean of Detached Thermometers. 40°	60°	80°	Proportionate Parts for Difference of Attached Thermometers.	
	Correction.	Correction.	Correction.	Diff. At. Th.	Prop. Parts.
°	ft.	ft.	ft.	°	ft.
0	0	0	0		
10	24	25	26	4	10·
20	48	50	52	5	12·5
30	71	74	77	6	15·
40	95	99	103	7	17·5
50	119	124	129	8	20·
60	143	149	155	9	22·5

This table has been constructed by Mr. J. O'Farrell, of the Ordnance Survey, with the view of abridging and simplifying the computation of heights from barometrical observations. It is applicable to ranges of height not exceeding 10,000 or 12,000 feet above the level of the sea, and may be employed with confidence for every practical purpose, as the resulting error of computation will not, except in the most extreme state of the atmosphere, exceed that due to the errors of observation and uncertainty in the elements of the calculation.

Description of Table.

The table consists of two parts: The *first part* is a Table of single entry, containing a series of numbers corresponding to every tenth of an inch of apparent mean barometrical pressure from 25·0 inches to 30·9 inches inclusive. The columns of proportional parts for ·02, ·04, ·06, ·08, serve for taking out at sight the tabular number answering to any value of the argument between the above limits. Thus, to find the tabular number for 28·66 inches: we have for 28·6 the tabular number = 854·3; from which subtracting 2·1, the proportional part for ·06 (found in the same horizontal line), we obtain the tabular number for 28·66 to be 852·2. In general it will be quite sufficient to take the nearest unit of the tabular numbers.

The *second part* is a small Table of double entry, and contains a correction depending on the difference of the attached thermometers, and the mean of the detached thermometers, successive values of which are made the arguments of the Table. This correction is *subtractive* or *additive* according as the reading of the upper attached is *less* or *greater* than that of the lower attached thermometer. It is generally very small, and can be taken from the table almost at sight.

Construction of Table.

The tabular numbers (Part I.) have been derived from the following formula, which has been obtained from consideration of the values of the quotient $\frac{\text{Diff. of heights}}{\text{Diff. of Barometers}}$ which obtain at different elevations in the mean state of the atmosphere :—

Tabular number $= 793 + 30\,(30{\cdot}5 - B_1) + (30{\cdot}5 - B_1)^2 + \frac{1}{10}(30{\cdot}5 - B_1)^3$ where B_1 is put for the existing mean barometric pressure.

The correction for difference of temperature of mercury (Part II.) has been derived from the expansions of mercury and brass adopted by *Schumacher* in his well-known table of reduction to the freezing point. When, therefore, the readings of the barometers have been (or can conveniently be) reduced to the standard temperature,

this correction becomes unnecessary, and the difference of heights may be computed by the sole use of the tabular numbers of Part I.

Rule and Examples.

Having given the simultaneous readings (corrected for instrumental errors) of the barometer in inches, of the attached and detached thermometers in degrees Fahrenheit, at two stations, to find the approximate difference of level between them, we have the following practical rule :—

Add the tabular number from table *Part I.* corresponding to the half sum of the readings of the barometers to the sum of the readings of the detached thermometers, and multiply this sum by the difference of the barometers; then, from the product thus found, *subtract* (*add*, if the reading of the upper attached thermometer be the *greater*) the correction from table *Part II.* corresponding to the difference of the attached thermometers, and found in the column headed "*Mean of detached thermometers*," which most nearly corresponds with the mean of the readings of the detached thermometers. The result is the correct difference of height in feet sought.

To prevent misapprehension, and make the process of computation perfectly clear, the following example is worked out at length :—

By a mean of a series of observations taken at Ben Lomond in June and July 1855, the following readings (corrected for instrumental errors) were obtained :—

	Barometers.	Att. Ther.	Det. Ther.	
At Base	29·890 inches	60°·8	59°·0	Mean = 53°·4
On Summit	26·656 „	49·3	47·8	
	2)56·546	Diff. = 11·5		

Mean = ½ sum = 28·273 ... Corresponding Tab. No. (Part I.) = 866·0

Sum = 972·8

Difference = 3·234 .... Multiply by ... 3·234

[Decimals beyond the first to be omitted in the usual way.]

3·8912
29·184
194·56
2918·4

Product = 3146·0352

Diff. Att. Ther. = 11·5 } Mean Det. Ther. = 53·4 } Corres. Tab. Correc. (Part. II.) = 28·7 ... subtract.

Resulting approximate difference of Heights .... = 3117·3 feet.
True difference of Heights by Leveling .... = 3115·8 „

Excess .... 1·5 „

Instead of this correction from table (Part II.), we may, unless in extreme states of the atmosphere, take 2½ times the difference of attached thermometers. Thus, in the present example, we should have the correction in question equal to

$$11 \cdot 5 \times 2\tfrac{1}{2} = \frac{115}{4} = 28 \cdot 75.$$

It will serve the purpose of further exemplification to recompute this example by using the barometrical readings reduced to the standard temperatures. Employing *Schumacher's Reduction Table*, these are 29·803 inches for the lower, and 26·606 for the upper barometer; the detached thermometers are, as before, 59·0 and 47·8, respectively. With those quantities the computation of the difference of heights of the stations is performed by the same rule, omitting the correction for difference of temperatures. Thus:—

	Barometers.		
At Base	29·803 inches	Detached Ther.	59°·0
On Summit	26·606 „	„ „	47·8
	2)56·409		

Mean = ½ sum = 28·205 ... Corresponding Tab. No. (Part I.) = 868·3

Sum = 975·1

Difference ... = 3·197 .... Multiply by ... 3·197

6·8257
87·759
97·51
2925·3

Approximate Diff. of Heights in feet = 3117·3947 the same as before.

Note.—In this approximate method no account is taken of the very small corrections for latitude and for the absolute heights of the stations above the sea.

Quakaka Creek

TABLE IV.

Table of the Elastic Force or Tension of Aqueous Vapour, for deducing the Temperature of the Dew-Point from the Observations of a Dry and Moist Bulb Thermometer, by Apjohn's Formula.

Tension of Vapour in Inches of Mercury for Degrees of Fahrenheit's Thermometer.									
Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.
−22°·0	·01437	−18°·0	·01729	−14°·0	·02077	−10°·0	·02503	−6°·0	·03019
·9	·01444	·9	·01737	·9	·02087	·9	·02515	·9	·03033
·8	·01451	·8	·01745	·8	·02097	·8	·02527	·8	·03047
·7	·01458	·7	·01753	·7	·02107	·7	·02539	·7	·03061
·6	·01465	·6	.01761	·6	·02117	·6	·02551	·6	·03075
·5	·01472	·5	·01769	·5	·02127	·5	·02563	·5	·03089
·4	·01479	·4	·01777	·4	·02137	·4	·02575	·4	·03103
·3	·01486	·3	·01785	·3	·02147	·3	·02587	·3	·03117
·2	·01493	·2	·01793	·2	·02157	·2	·02599	·2	·03131
·1	·01500	·1	·01801	·1	·02167	·1	·02611	·1	·03146
−21·0	·01507	−17·0	·01809	−13·0	·02177	−9·0	·02623	−5·0	·03161
·9	·01514	·9	·01817	·9	·02187	·9	·02635	·9	·03176
·8	·01521	·8	·01825	·8	·02197	·8	·02647	·8	·03191
·7	·01528	·7	·01833	·7	·02207	·7	·02659	·7	·03206
·6	·01535	·6	·01842	·6	·02217	·6	·02671	·6	·03221
·5	·01542	·5	·01851	·5	·02227	·5	·02683	·5	·03236
·4	·01549	·4	·01860	.4	·02238	·4	·02695	·4	·03251
·3	·01556	·3	·01869	·3	.02249	·3	·02708	·3	·03266
·2	·01563	·2	·01878	·2	·02260	·2	·02721	·2	·03281
·1	·01570	·1	·01887	·1	·02271	·1	·02734	·1	·03296
−20·0	·01577	−16·0	·01896	−12·0	·02282	−8·0	·02747	−4·0	·03311
·9	·01584	·9	·01905	·9	·02293	·9	·02760	·9	·03327
·8	·01591	·8	·01914	·8	·02304	·8	·02773	·8	·03343
·7	·01598	·7	·01923	·7	·02315	·7	·02786	·7	·03359
·6	·01605	·6	·01932	·6	·02326	·6	·02799	·6	·03375
·5	·01612	·5	·01941	·5	·02337	·5	·02812	·5	·03391
·4	·01619	·4	·01950	·4	·02348	·4	·02825	·4	·03407
·3	·01626	·3	·01959	·3	·02359	·3	·02838	·3	·03423
·2	·01633	·2	·01968	·2	·02370	·2	·02851	·2	·03439
·1	·01641	·1	·01977	·1	·02381	·1	·02865	·1	·03455
−19·0	·01649	−15·0	·01986	−11·0	·02392	−7·0	·02879	−3·0	·03471
·9	·01657	·9	·01995	·9	·02403	·9	·02893	·9	·03487
·8	·01665	·8	·02004	·8	·02414	·8	·02907	·8	·03504
·7	·01673	·7	·02013	·7	·02425	·7	·02921	·7	·03521
·6	·01681	·6	·02022	·6	·02436	·6	·02935	·6	·03538
·5	·01689	·5	·02031	·5	·02447	·5	·02949	·5	·03555
·4	·01697	·4	·02040	·4	·02458	·4	·02963	·4	·03572
·3	·01705	·3	·02049	·3	·02469	·3	·02977	·3	·03589
·2	·01713	·2	·02058	·2	·02480	·2	·02991	·2	·03606
·1	·01721	·1	·02067	·1	·02491	·1	·03005	·1	·03623

Table IV.—Table of the Elastic Force or Tension of Aqueous Vapour, &c.—*cont.*

Tension of Vapour in Inches of Mercury for Degrees of Fahrenheit's Thermometer.									
Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.
−2°·0	·03640	3°·0	·04600	8°·0	·05821	13°·0	·07373	18°·0	·09337
·9	·03657	·1	·04621	·1	·05848	·1	·07408	·1	·09381
·8	·03674	·2	·04642	·2	·05876	·2	·07443	·2	·09425
·7	·03691	·3	·04663	·3	·05904	·3	·07478	·3	·09470
·6	·03708	·4	·04685	·4	·05932	·4	·07513	·4	·09515
·5	·03725	·5	·04707	·5	·05960	·5	·07548	·5	·09560
·4	·03742	·6	·04729	·6	·05988	·6	·07584	·6	·09605
·3	·03759	·7	·04751	·7	·06016	·7	·07620	·7	·09650
·2	·03777	·8	·04773	·8	·06044	·8	·07656	·8	·09696
·1	·03795	·9	·04796	·9	·06073	·9	·07692	·9	·09742
−1·0	·03813	4·0	·04819	9·0	·06102	14·0	·07728	19·0	·09788
·9	·03831	·1	·04842	·1	·06131	·1	·07765	·1	·09834
·8	·03849	·2	·04865	·2	·06160	·2	·07802	·2	·09880
·7	·03867	·3	·04888	·3	·06189	·3	·07839	·3	·09926
·6	·03885	·4	·04911	·4	·06218	·4	·07876	·4	·09973
·5	·03903	·5	·04935	·5	·06248	·5	·07914	·5	·10020
·4	·03921	·6	·04959	·6	·06278	·6	·07952	·6	·10067
·3	·03940	·7	·04983	·7	·06308	·7	·07990	·7	·10115
·2	·03959	·8	·05007	·8	·06338	·8	·08028	·8	·10163
−·1	·03978	·9	·05031	·9	·06368	·9	·08066	·9	·10211
0·0	·03997	5·0	·05055	10·0	·06398	15·0	·08104	20·0	·10259
+·1	·04016	·1	·05079	·1	·06428	·1	·08142	·1	·10308
·2	·04035	·2	·05103	·2	·06458	·2	·08180	·2	·10357
·3	·04054	·3	·05128	·3	·06489	·3	·08219	·3	·10406
·4	·04073	·4	·05153	·4	·06520	·4	·08258	·4	·10455
·5	·04092	·5	·05178	·5	·06551	·5	·08297	·5	·10505
·6	·04111	·6	·05203	·6	·06582	·6	·08336	·6	·10555
·7	·04130	·7	·05228	·7	·06613	·7	·08375	·7	·10605
·8	·04149	·8	·05253	·8	·06644	·8	·08414	·8	·10655
·9	·04168	·9	·05278	·9	·06676	·9	·08454	·9	·10706
1·0	·04188	6·0	·05303	11·0	·06708	16·0	·08494	21·0	·10757
·1	·04208	·1	·05328	·1	·06740	·1	·08534	·1	·10808
·2	·04228	·2	·05353	·2	·06772	·2	·08574	·2	·10859
·3	·04248	·3	·05378	·3	·06804	·3	·08615	·3	·10911
·4	·04268	·4	·05403	·4	·06836	·4	·08656	·4	·10963
·5	·04288	·5	·05428	·5	·06868	·5	·08697	·5	·11015
·6	·04308	·6	·05453	·6	·06901	·6	·08738	·6	·11067
·7	·04328	·7	·05478	·7	·06934	·7	·08779	·7	·11120
·8	·04348	·8	·05504	·8	·06967	·8	·08821	·8	·11173
·9	·04369	·9	·05530	·9	·07000	·9	·08863	·9	·11226
2·0	·04390	7·0	·05556	12·0	·07033	17·0	·08905	22·0	·11279
·1	·04411	·1	·05582	·1	·07066	·1	·08947	·1	·11333
·2	·04432	·2	·05608	·2	·07099	·2	·08990	·2	·11387
·3	·04453	·3	·05634	·3	·07133	·3	·09033	·3	·11441
·4	·04474	·4	·05660	·4	·07167	·4	·09076	·4	·11495
·5	·04495	·5	·05686	·5	·07201	·5	·09119	·5	·11549
·6	·04516	·6	·05713	·6	·07235	·6	·09162	·6	·11604
·7	·04537	·7	·05740	·7	·07269	·7	·09205	·7	·11659
·8	·04558	·8	·05767	·8	·07303	·8	·09249	·8	·11715
·9	·04579	·9	·05794	·9	·07338	·9	·09293	·9	·11771

TABLE IV.—Table of the Elastic Force or Tension of Aqueous Vapour, &c.—*cont.*

Tension of Vapour in Inches of Mercury for Degrees of Fahrenheit's Thermometer.									
Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.
23°·0	·11827	28°·0	·14982	33°·0	·18839	38°·0	·22918	43°·0	·27761
·1	·11883	·1	·15053	·1	·18914	·1	·23007	·1	·27866
·2	·11939	·2	·15125	·2	·18989	·2	·23096	·2	·27972
·3	·11996	·3	·15197	·3	·19065	·3	·23185	·3	·28078
·4	·12053	·4	·15270	·4	·19141	·4	·23275	·4	·28185
·5	·12110	·5	·15343	·5	·19218	·5	·23365	·5	·28292
·6	·12167	·6	·15416	·6	·19295	·6	·23455	·6	·28400
·7	·12225	·7	·15490	·7	·19372	·7	·23546	·7	·28508
·8	·12283	·8	·15564	·8	·19449	·8	·23637	·8	·28616
·9	·12341	·9	·15638	·9	·19526	·9	·23728	·9	·28725
24·0	·12399	29·0	·15713	34·0	·19603	39·0	·23820	44·0	·28834
·1	·12458	·1	·15788	·1	·19680	·1	·23912	·1	·28943
·2	·12517	·2	·15863	·2	·19758	·2	·24005	·2	·29053
·3	·12576	·3	·15939	·3	·19836	·3	·24098	·3	·29163
·4	·12636	·4	·16015	·4	·19914	·4	·24191	·4	·29274
·5	·12696	·5	·16091	·5	·19993	·5	·24284	·5	·29385
·6	·12756	·6	·16167	·6	·20072	·6	·24378	·6	·29497
·7	·12817	·7	·16243	·7	·20151	·7	·24472	·7	·29609
·8	·12878	·8	·16320	·8	·20230	·8	·24566	·8	·29721
·9	·12939	·9	·16397	·9	·20310	·9	·24660	·9	·29834
25·0	·13000	30·0	·16474	35·0	·20390	40·0	·24755	45·0	·29947
·1	·13062	·1	·16552	·1	·20470	·1	·24850	·1	·30060
·2	·13124	·2	·16630	·2	·20551	·2	·24946	·2	·30174
·3	·13186	·3	·16709	·3	·20632	·3	·25042	·3	·30288
·4	·13249	·4	·16788	·4	·20713	·4	·25138	·4	·30402
·5	·13312	·5	·16867	·5	·20794	·5	·25235	·5	·30517
·6	·13375	·6	·16947	·6	·20876	·6	·25332	·6	·30632
·7	·13438	·7	·17027	·7	·20958	·7	·25429	·7	·30747
·8	·13502	·8	·17108	·8	·21040	·8	·25527	·8	·30863
·9	·13566	·9	·17189	·9	·21123	·9	·25626	·9	·30979
26·0	·13630	31·0	·17271	36·0	·21206	41·0	·25725	46·0	·31095
·1	·13694	·1	·17353	·1	·21289	·1	·25824	·1	·31212
·2	·13759	·2	·17436	·2	·21372	·2	·25923	·2	·31329
·3	·13824	·3	·17519	·3	·21456	·3	·26023	·3	·31446
·4	·13889	·4	·17603	·4	·21540	·4	·26123	·4	·31564
·5	·13954	·5	·17687	·5	·21624	·5	·26223	·5	·31682
·6	·14020	·6	·17771	·6	·21709	·6	·26323	·6	·31800
·7	·14086	·7	·17855	·7	·21794	·7	·26424	·7	·31919
·8	·14153	·8	·17940	·8	·21879	·8	·26525	·8	·32038
·9	·14220	·9	·18025	·9	·21964	·9	·26626	·9	·32158
27·0	·14287	32·0	·18111	37·0	·22049	42·0	·26727	47·0	·32278
·1	·14355	·1	·18183	·1	·22135	·1	·26829	·1	·32399
·2	·14423	·2	·18255	·2	·22221	·2	·26931	·2	·32520
·3	·14492	·3	·18327	·3	·22307	·3	·27033	·3	·32642
·4	·14561	·4	·18399	·4	·22393	·4	·27136	·4	·32764
·5	·14630	·5	·18472	·5	·22480	·5	·27239	·5	·32887
·6	·14700	·6	·18545	·6	·22567	·6	·27343	·6	·33010
·7	·14770	·7	·18618	·7	·22654	·7	·27447	·7	·33133
·8	·14840	·8	·18691	·8	·22742	·8	·27551	·8	·33257
·9	·14911	·9	·18765	·9	·22830	·9	·27656	·9	·33381

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Table IV.—Table of the Elastic Force or Tension of Aqueous Vapour, &c.—*cont.*

Tension of Vapour in Inches of Mercury for Degrees of Fahrenheit's Thermometer.									
Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.
48°·0	·33506	53°·0	·40275	58°·0	·48245	63°·0	·57578	68°·0	·68470
·1	·33631	·1	·40422	·1	·48417	·1	·57780	·1	·68705
·2	·33757	·2	·40570	·2	·48590	·2	·57983	·2	·68941
·3	·33883	·3	·40719	·3	·48764	·3	·58186	·3	·69177
·4	·34009	·4	·40868	·4	·48938	·4	·58390	·4	·69414
·5	·34136	·5	·41017	·5	·49113	·5	·58595	·5	·69652
·6	·34263	6	·41167	·6	·49288	·6	·58800	·6	·69890
·7	·34391	·7	·41317	·7	·49464	·7	·59006	·7	·70129
·8	·34519	·8	·41468	·8	·49641	·8	·59212	·8	·70369
·9	·34647	·9	·41619	·9	·49818	·9	·59419	·9	·70610
49·0	·34776	54·0	·41771	59·0	·49996	64·0	·59627	69·0	·70852
·1	·34905	·1	·41923	·1	·50174	·1	·59835	·1	·71095
·2	·35034	·2	·42076	·2	·50353	·2	·60044	·2	·71339
·3	·35164	·3	·42229	·3	·50532	·3	·60253	·3	·71584
·4	·35294	·4	·42383	·4	·50711	·4	·60463	·4	·71830
·5	·35425	·5	·42537	·5	·50891	·5	·60673	·5	·72076
·6	·35556	·6	·42692	·6	·51072	·6	·60884	·6	·72323
·7	·35688	·7	·42847	·7	·51253	·7	·61096	·7	·72571
·8	·35820	·8	·43003	·8	·51435	·8	·61308	·8	·72819
·9	·35952	·9	·43159	·9	·51618	·9	·61521	·9	·73068
50·0	·36084	55·0	·43316	60·0	·51801	65·0	·61735	70·0	·73317
·1	·36217	·1	·43473	·1	·51985	·1	·61950	·1	·73567
·2	·36350	·2	·43630	·2	·52169	·2	·62165	·2	·73818
·3	·36474	·3	·43788	·3	·52354	·3	·62381	·3	·74069
·4	·36618	·4	·43946	·4	·52540	·4	·62598	·4	·74321
·5	·36753	·5	·44105	·5	·52726	·5	·62815	·5	·74574
·6	·36888	·6	·44264	·6	·52913	·6	·63033	·6	·74827
·7	·37024	·7	·44424	·7	·53101	·7	·63252	·7	·75081
·8	·37160	·8	·44584	·8	·53290	·8	·63472	·8	·75335
·9	·37297	·9	·44745	·9	·53480	·9	·63692	·9	·75590
51·0	·37434	56·0	·44907	61·0	·53670	66·0	·63913	71·0	·75846
·1	·37572	·1	·45069	·1	·53860	·1	·64134	·1	·76103
·2	·37710	·2	·45232	·2	·54051	·2	·64356	·2	·76361
·3	·37849	·3	·45395	·3	·54242	·3	·64578	·3	·76620
·4	·37988	·4	·45559	·4	·54434	·4	·64801	·4	·76879
·5	·38128	·5	·45723	·5	·54626	5	·65025	·5	·77139
·6	·38268	·6	·45888	·6	·54819	·6	·65250	·6	·77399
·7	·38409	·7	·46053	·7	·55012	·7	·65475	·7	·77660
·8	·38550	·8	·46219	·8	·55206	·8	·65701	·8	·77922
·9	·38692	·9	·46385	·9	·55400	·9	·65928	·9	·78185
52·0	·38834	57·0	·46552	62·0	·55595	67·0	·66156	72·0	·78449
·1	·38976	·1	·46719	·1	·55790	·1	·66385	·1	·78713
·2	·39118	·2	·46886	·2	·55986	·2	·66614	·2	·78978
·3	·39261	·3	·47054	·3	·56183	·3	·66844	·3	·79244
·4	·39404	·4	·47222	·4	·56380	·4	·67074	·4	·79511
·5	·39548	·5	·47391	·5	·56578	·5	·67305	·5	·79779
·6	·39692	·6	·47561	·6	·56777	·6	·67537	·6	·80048
·7	·39837	·7	·47731	·7	·56976	·7	·67769	·7	·80318
·8	·39982	·8	·47902	·8	·57176	·8	·68002	·8	·80589
·9	·40128	·9	·48073	·9	·57377	·9	·68236	·9	·80861

Table IV.—Table of the Elastic Force or Tension of Aqueous Vapour, &c.—*cont.*

Tension of Vapour in Inches of Mercury for Degrees of Fahrenheit's Thermometer.

Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.
73°·0	·81134	78°·0	·95829	83°·0	1·12802	88°·0	1·32356	93°·0	1·54808
·1	·81408	·1	·96145	·1	1·13167	·1	1·32774	·1	1·55289
·2	·81683	·2	·96462	·2	1·13533	·2	1·33193	·2	1·55771
·3	·81959	·3	·96779	·3	1·13900	·3	1·33613	·3	1·56254
·4	·82236	·4	·97097	·4	1·14268	·4	1·34035	·4	1·56739
·5	·82513	·5	·97416	·5	1·14637	·5	1·34458	·5	1·57225
·6	·82791	·6	·97736	·6	1·15008	·6	1·34883	·6	1·57712
·7	·83070	·7	·98057	·7	1·15380	·7	1·35310	·7	1·58200
·8	·83350	·8	·98379	·8	1·15753	·8	1·35738	·8	1·58690
·9	·83630	·9	·98702	·9	1·16127	·9	1·36167	·9	1·59181
74·0	·83911	79·0	·99026	84·0	1·16502	89·0	1·36597	94·0	1·59673
·1	·84193	·1	·99351	·1	1·16878	·1	1·37029	·1	1·60167
·2	·84476	·2	·99677	·2	1·17255	·2	1·37462	·2	1·60662
·3	·84759	·3	1·00004	·3	1·17633	·3	1·37897	·3	1·61158
·4	·85043	·4	1·00332	·4	1·18012	·4	1·38333	·4	1·61656
·5	·85328	·5	1·00661	·5	1·18392	·5	1·38771	·5	1·62155
·6	·85613	·6	1·00991	·6	1·18773	·6	1·39210	·6	1·62656
·7	·85899	·7	1·01322	·7	1·19155	·7	1·39650	·7	1·63158
·8	·86186	·8	1·01654	·8	1·19538	·8	1·40091	·8	1·63662
·9	·86474	·9	1·01987	·9	1·19922	·9	1·40533	·9	1·64167
75·0	·86768	80·0	1·02321	85·0	1·20307	90·0	1·40976	95·0	1·64674
·1	·87052	·1	1·02656	·1	1·20693	·1	1·41420	·1	1·65182
·2	·87342	·2	1·02992	·2	1·21080	·2	1·41865	·2	1·65691
·3	·87633	·3	1·03329	·3	1·21468	·3	1·42311	·3	1·66202
·4	·87925	·4	1·03668	·4	1·21857	·4	1·42758	·4	1·66714
·5	·88218	·5	1·04008	·5	1·22247	·5	1·43206	·5	1·67227
·6	·88512	·6	1·04350	·6	1·22638	·6	1·43656	·6	1·67742
·7	·88806	·7	1·04692	·7	1·23030	·7	1·44107	·7	1·68258
·8	·89101	·8	1·05035	·8	1·23423	·8	1·44559	·8	1·68775
·9	·89397	·9	1·05379	·9	1·23817	·9	1·45012	·9	1·69294
76·0	·89694	81·0	1·05724	86·0	1·24212	91·0	1·45466	96·0	1·69814
·1	·89992	·1	1·06069	·1	1·24608	·1	1·45921	·1	1·70335
·2	·90291	·2	1·06415	·2	1·25005	·2	1·46377	·2	1·70857
·3	·90591	·3	1·06762	·3	1·25403	·3	1·46835	·3	1·71381
·4	·90892	·4	1·07110	·4	1·25802	·4	1·47294	·4	1·71906
·5	·91194	·5	1·07459	·5	1·26202	·5	1·47754	·5	1·72433
·6	·91497	·6	1·07808	·6	1·26604	·6	1·48215	·6	1·72961
·7	·91801	·7	1·08158	·7	1·27007	·7	1·48678	·7	1·73491
·8	·92106	·8	1·08509	·8	1·27411	·8	1·49142	·8	1·74023
·9	·92412	·9	1·08861	·9	1·27817	·9	1·49607	·9	1·74556
77·0	·92719	82·0	1·09214	87·0	1·28224	92·0	1·50073	97·0	1·75090
·1	·93026	·1	1·09568	·1	1·28632	·1	1·50541	·1	1·75626
·2	·93334	·2	1·09923	·2	1·29041	·2	1·51010	·2	1·76163
·3	·93643	·3	1·10279	·3	1·29452	·3	1·51480	·3	1·76702
·4	·93953	·4	1·10636	·4	1·29864	·4	1·51951	·4	1·77242
·5	·94264	·5	1·10994	·5	1·30277	·5	1·52424	·5	1·77783
·6	·94575	·6	1·11353	·6	1·30691	·6	1·52898	·6	1·78326
·7	·94887	·7	1·11713	·7	1·31106	·7	1·53373	·7	1·78870
·8	·95200	·8	1·12075	·8	1·31522	·8	1·53850	·8	1·79416
·9	·95514	·9	1·12438	·9	1·31939	·9	1·54328	·9	1·79963

TABLE IV.—Table of the Elastic Force or Tension of Aqueous Vapour, &c.—*cont.*

Tension of Vapour in Inches of Mercury for Degrees of Fahrenheit's Thermometer.									
Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.
98°·0	1·80511	103°·0	2·09830	108°·0	2·43209	113°·0	2·81073	118°·0	3·23930
·1	1·81060	·1	2·10456	·1	2·43921	·1	2·81879	·1	3·24841
·2	1·81611	·2	2·11083	·2	2·44635	·2	2·82687	·2	3·25754
·3	1·82163	·3	2·11712	·3	2·45351	·3	2·83497	·3	3·26669
·4	1·82716	·4	2·12343	·4	2·46069	·4	2 84309	·4	3·27586
·5	1·83271	·5	2·12976	·5	2·46788	·5	2·85123	·5	3·28505
·6	1·83827	·6	2·13610	·6	2 47509	·6	2·85939	·6	3·29426
·7	1·84385	·7	2·14246	·7	2·48231	·7	2·86757	·7	3·30350
·8	1·84944	·8	2·14884	·8	2·48955	·8	2·87577	·8	3·31276
·9	1·85505	·9	2·15524	·9	2·49681	·9	2·88399	·9	3·32205
99·0	1·86067	104·0	2·16166	109·0	2·50409	114·0	2·89223	119·0	3·33136
·1	1·86631	·1	2·16810	·1	2·51139	·1	2·90049	·1	3·34069
·2	1·87196	·2	2·17455	·2	2·51870	·2	2·90877	·2	3·35004
·3	1·87763	·3	2·18102	·3	2·52603	·3	2·91708	·3	3·35941
·4	1·88332	·4	2·18750	·4	2·53338	·4	2·92541	·4	3·36881
·5	1·88902	·5	2·19400	·5	2·54075	·5	2·93376	·5	3·37823
·6	1·89474	·6	2·20052	·6	2·54814	·6	2·94213	·6	3·38768
·7	1·90047	·7	2·20706	·7	2·55554	·7	2·95053	·7	3·39716
·8	1·90622	·8	2·21361	·8	2·56296	·8	2·95895	·8	3·40666
·9	1·91199	·9	2·22018	·9	2·57040	·9	2·96739	·9	3·41619
100·0	1·91777	105·0	2·22676	110·0	2·57786	115·0	2·97585	120·0	3·42574
·1	1·92357	·1	2·23336	·1	2·58534	·1	2·98433	·1	3·43532
·2	1·92939	·2	2·23997	·2	2·59284	·2	2·99283	·2	3·44492
·3	1·93522	·3	2·24660	·3	2·60036	·3	3·00135	·3	3·45454
·4	1·94107	·4	2·25324	·4	2·60790	·4	3·00989	·4	3·46418
·5	1·94693	·5	2·25990	·5	2·61546	·5	3·01845	·5	3·47385
·6	1·95280	·6	2·26658	·6	2·62304	·6	3·02703	·6	3·48354
·7	1·95869	·7	2·27327	·7	2·63064	·7	3·03563	·7	3·49325
·8	1·96459	·8	2·27998	·8	2·63826	·8	3·04425	·8	3·50298
·9	1·97051	·9	2·28670	·9	2·64590	·9	3·05289	·9	3·51273
101·0	1·97644	106·0	2·29344	111·0	2·65356	116·0	3·06155	121·0	3·52250
·1	1·98239	·1	2·30020	·1	2·66124	·1	3·07023	·1	3·5322[illegible]
·2	1·98835	·2	2·30698	·2	2·66894	·2	3·07893	·2	3·54210
·3	1·99433	·3	2·31377	·3	2·67666	·3	3·08765	·3	3·55194
·4	2·00032	·4	2·32058	·4	2·68439	·4	3·09640	·4	3·56180
·5	2·00633	·5	2·32741	·5	2·69214	·5	3·10517	·5	3·57168
·6	2·01235	·6	2·33426	·6	2·69991	·6	3·11397	·6	3·58158
·7	2·01839	·7	2·34113	·7	2·70770	·7	3·12279	·7	3·59150
·8	2·02444	·8	2·34802	·8	2·71551	·8	3·13163	·8	3·60145
·9	2·03051	·9	2·35492	·9	2·72334	·9	3·14049	·9	3·61142
102·0	2·03659	107·0	2·36184	112·0	2·73119	117·0	3·14937	122·0	3·62142
·1	2·04269	·1	2·36878	·1	2·73906	·1	3·15827	·1	3·63144
·2	2·04881	·2	2·37574	·2	2·74695	·2	3·16719	·2	3·64148
·3	2·05494	·3	2·38272	·3	2 75486	·3	3·17613	·3	3·65155
·4	2·06109	·4	2·38972	·4	2·76279	·4	3·18509	·4	3·66164
·5	2·06726	·5	2·39674	·5	2·77073	·5	3·19407	·5	6·67176
·6	2·07344	·6	2·40378	·6	2·77869	·6	3 20307	·6	3·68190
·7	2·07963	·7	2·41083	·7	2·78667	·7	3·21209	·7	3·69207
·8	2·08584	·8	2·41790	·8	2·79467	·8	3·22114	·8	3·70226
·9	2·09206	·9	2·42499	·9	2·80269	·9	3·23021	·9	3·71248

TABLE IV.—Table of the Elastic Force or Tension of Aqueous Vapour, &c.—*cont.*

Tension of Vapour in Inches of Mercury for Degrees of Fahrenheit's Thermometer.									
Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.
123°·0	3·72272	128°·0	4·26710	133°·0	4·87803	138°·0	5·56225	143°·0	6·32675
·1	3·73299	·1	4·27865	·1	4·89097	·1	5·57674	·1	6·34290
·2	3·74328	·2	4·29023	·2	4·90394	·2	5·59127	·2	6·35908
·3	3·75360	·3	4·30184	·3	4·91694	·3	5·60583	·3	6·37530
·4	3·76395	·4	4·31347	·4	4·92997	·4	5·62042	·4	6·39155
·5	3·77433	·5	4·32512	·5	4·94303	·5	5·63504	·5	6·40784
·6	3·78474	·6	4·33680	·6	4·95612	·6	5·64969	·6	6·42416
·7	3·79518	·7	4·34851	·7	4·96924	·7	5·66437	·7	6·44052
·8	3·80564	·8	4·36024	·8	4·98239	·8	5·67909	·8	6·45691
·9	3·81612	·9	4·37199	·9	4·99557	·9	5·69384	·9	6·47334
124·0	3·82662	129·0	4·38377	134·0	5·00878	139·0	5·70862	144·0	6·48980
·1	3·83715	·1	4·39556	·1	5·02203	·1	5·72343	·1	6·50630
·2	3·84770	·2	4·40739	·2	5·03531	·2	5·73827	·2	6·52284
·3	3·85827	·3	4·41925	·3	5·04862	·3	5·75314	·3	6·53941
·4	3·86887	·4	4·43113	·4	5·06196	·4	5·76804	·4	6·55602
·5	3·87949	·5	4·44304	·5	5·07533	·5	5·78297	·5	6·57267
·6	3·89013	·6	4·45498	·6	5·08873	·6	5·79793	·6	6·58936
·7	3·90080	·7	4·46695	·7	5·10216	·7	5·81292	·7	6·60608
·8	3·91149	·8	4·47895	·8	5·11562	·8	5·82794	·8	6·62284
·9	3·92221	·9	4·49098	·9	5·12911	·9	5·84299	·9	6·63964
125·0	3·93295	130·0	4·50304	135·0	5·14263	140·0	5·85807	145·0	6·65648
·1	3·94371	·1	4·51513	·1	5·15618	·1	5·87318	·1	6·67335
·2	3·95449	·2	4·52725	·2	5·16976	·2	5·88833	·2	6·69026
·3	3·96530	·3	4·53940	·3	5·18337	·3	5·90351	·3	6·70721
·4	3·97614	·4	4·55157	·4	5·19701	·4	5·91873	·4	6·72420
·5	3·98700	·5	4·56377	·5	5·21068	·5	5·93398	·5	6·74122
·6	3·99788	·6	4·57600	·6	5·22438	·6	5·94927	·6	6·75828
·7	4·00878	·7	4·58826	·7	5·23811	·7	5·96459	·7	6·77538
·8	4·01971	·8	4·60055	·8	5·25187	·8	5·97995	·8	6·79251
·9	4·03066	·9	4·61287	·9	5·26565	·9	5·99534	·9	6·80968
126·0	4·04164	131·0	4·62522	136·0	5·27946	141·0	6·01077	146·0	6·82688
·1	4·05265	·1	4·63760	·1	5·29330	·1	6·02623	·1	6·84412
·2	4·06368	·2	4·65000	·2	5·30717	·2	6·04173	·2	6·86139
·3	4·07474	·3	4·66243	·3	5·32107	·3	6·05727	·3	6·87870
·4	4·08583	·4	4·67489	·4	5·33500	·4	6·07285	·4	6·89605
·5	4·09694	·5	4·68738	·5	4·34896	·5	6·08847	·5	6·91343
·6	4·10808	·6	4·69990	·6	5·36295	·6	6·10412	·6	6·93085
·7	4·11925	·7	4·71244	·7	5·37697	·7	6·11980	·7	6·94830
·8	4·13045	·8	4·72501	·8	5·39103	·8	6·13552	·8	6·96579
·9	4·14168	·9	4·73761	·9	5·40512	·9	6·15126	·9	6·98332
127·0	4·15294	132·0	4·75024	137·0	5·41924	142·0	6·16705	147·0	7·00089
·1	4·16423	·1	4·76289	·1	5·43339	·1	6·18287	·1	7·01850
·2	4·17555	·2	4·77558	·2	5·44758	·2	6·19872	·2	7·03615
·3	4·18690	·3	4·78829	·3	5·46180	·3	6·21460	·3	7·05384
·4	4·19828	·4	4·80102	·4	5·47605	·4	6·23052	·4	7·07157
·5	4·20969	·5	4·81378	·5	5·49034	·5	6·24647	·5	7·08933
·6	4·22112	·6	4·82657	·6	5·50466	·6	6·26246	·6	7·10713
·7	4·23258	·7	4·83939	·7	5·51901	·7	6·27848	·7	7·12497
·8	4·24406	·8	4·85224	·8	5·53339	·8	6·29454	·8	7·14284
·9	4·25557	·9	4·86512	·9	5·54780	·9	6·31063	·9	7·16075

Table IV.—Table of the Elastic Force or Tension of Aqueous Vapour, &c.—*cont.*

Tension of Vapour in Inches of Mercury for Degrees of Fahrenheit's Thermometer.									
Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.
148°·0	7·17870	153°·0	8·12595	158°·0	9·17709	163°·0	10·34095	168°·0	11·62652
·1	7·19668	·1	8·14592	·1	9·19325	·1	10·36543	·1	11·65355
·2	7·21470	·2	8·16594	·2	9·22146	·2	10·38995	·2	11·68064
·3	7·23275	·3	8·18600	·3	9·24371	·3	10·41451	·3	11·70778
·4	7·25084	·4	8·20610	·4	9·26600	·4	10·43912	·4	11·73498
·5	7·26897	·5	8·22625	·5	9·28834	·5	10·46378	·5	11·76223
·6	7·28714	·6	8·24644	·6	9·31072	·6	10·48849	·6	11·78953
·7	7·30534	·7	8·26667	·7	9·33314	·7	10·51325	·7	11·81689
·8	7·32358	·8	8·28694	·8	9·35561	·8	10·53806	·8	11·84430
·9	7·34286	·9	8·30725	·9	9·37812	·9	10·56292	·9	11·87176
149·0	7·36017	154·0	8·32761	159·0	9·40067	164·0	10·58783	169·0	11·89927
·1	7·37852	·1	8·34801	·1	9·42327	·1	10·61280	·1	11·92684
·2	7·39691	·2	8·36846	·2	9·44591	·2	10·63782	·2	11·95446
·3	7·41534	·3	8·38895	·3	9·46859	·3	10·66289	·3	11·98213
·4	7·43381	·4	8·40949	·4	9·49131	·4	10·68801	·4	12·00985
·5	7·45233	·5	8·43007	·5	9·51407	·5	10·71319	·5	12·03763
·6	7·47087	·6	8·45069	·6	9·53688	·6	10·73842	·6	12·06546
·7	7·48947	·7	8·47135	·7	9·55973	·7	10·76371	·7	12·09335
·8	7·50811	·8	8·49206	·8	9·58263	·8	10·78906	·8	12·12130
·9	7·52679	·9	8·51281	·9	9·60558	·9	10·81446	·9	12·14930
150·0	7·54551	155·0	8·53360	160·0	9·62858	165·0	10·83991	170·0	12·17736
·1	7·56427	·1	8·55443	·1	9·65162	·1	10·86541	·1	12·20547
·2	7·58307	·2	8·57530	·2	9·67471	·2	10·89096	·2	12·23363
·3	7·60192	·3	8·59621	·3	9·69785	·3	10·91655	·3	12·26184
·4	7·62081	·4	8·61716	·4	9·72103	·4	10·94219	·4	12·29010
·5	7·63975	·5	8·63815	·5	9·74426	·5	10·96788	·5	12·31841
·6	7·65873	·6	8·65918	·6	9·76754	·6	10·99362	·6	12·34677
·7	7·67754	·7	8·68025	·7	9·79087	·7	11·01941	·7	12·37519
·8	7·69682	·8	8·70136	·8	9·81425	·8	11·04525	·8	12·40366
·9	7·71593	·9	8·72251	·9	9·83768	·9	11·07114	·9	12·43219
151·0	7·73508	156·0	8·74371	161·0	9·86116	166·0	11·09707	171·0	12·46077
·1	7·75426	·1	8·76495	·1	9·88469	·1	11·12306	·1	12·48940
·2	7·77348	·2	8·78623	·2	9·90827	·2	11·14910	·2	12·51809
·3	7·79274	·3	8·80755	·3	9·93190	·3	11·17519	·3	12·54683
·4	7·81204	·4	8·82892	·4	9·95558	·4	11·20133	·4	12·57563
·5	7·83137	·5	8·85043	·5	9·97932	·5	11·22752	·5	12·60149
·6	7·85074	·6	8·87179	·6	10·00311	·6	11·25376	·6	12·63341
·7	7·87014	·7	8·89330	·7	10·02695	·7	11·28005	·7	12·66239
·8	7·88958	·8	8·91485	·8	10·05083	·8	11·30639	·8	12·69143
·9	7·90906	·9	8·93645	·9	10·07475	·9	11·33278	·9	12·72053
152·0	7·92857	157·0	8·95809	162·0	10·09872	167·0	11·35922	172·0	12·74968
·1	7·94812	·1	8·97978	·1	10·12274	·1	11·38571	·1	12·77889
·2	7·96771	·2	9·00151	·2	10·14680	·2	11·41225	·2	12·80816
:3	7·98734	·3	9·02329	·3	10·17091	·3	11·43885	·3	12·83749
·4	8·00701	·4	9·04512	·4	10·19507	·4	11·46550	·4	12·86687
·5	8·02673	·5	9·06699	·5	10·21927	·5	11·49220	·5	12·89631
·6	8·04649	·6	9·08891	·6	10·24351	·6	11·51895	·6	12·92581
·7	8·06629	·7	9·11088	·7	10·26780	·7	11·54576	·7	12·95336
·8	8·08613	·8	9·13290	·8	10·29214	·8	11·57262	·8	12·98497
·9	8·10602	·9	1·15497	·9	10·31652	·9	11·59954	·9	13·01464

TABLE IV.—Table of the Elastic Force or Tension of Aqueous Vapour, &c.—*cont.*

Tension of Vapour in Inches of Mercury for Degrees of Fahrenheit's Thermometer.									
Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.
173°·0	13·04436	178°·0	14·60447	183°·0	16·31816	188°·0	18·19713	193°·0	20·25386
·1	13·07413	·1	14·63719	·1	16·35408	·1	18·23648	·1	20·29690
·2	13·10396	·2	14·66997	·2	16·39006	·2	18·27590	·2	20·34001
·3	13·13384	·3	14·70281	·3	16·42611	·3	18·31539	·3	20·38320
·4	13·16378	·4	14·73572	·4	16·46223	·4	18·35496	·4	20·42646
·5	13·19378	·5	14·76869	·5	16·49842	·5	18·39461	·5	20·46979
·6	13·22384	·6	14·80172	·6	16·53467	·6	18·43433	·6	20·51319
·7	13·25396	·7	14·83482	·7	16·57099	·7	18·47412	·7	20·55666
·8	13·28413	·8	14·86798	·8	16·60737	·8	18·51398	·8	20·60020
·9	13·31435	·9	14·90121	·9	16·64382	·9	18·55391	·9	20·64381
174·0	13·34463	179·0	14·93450	184·0	16·68033	189·0	18·59391	194·0	20·68750
·1	13·37496	·1	14·96785	·1	16·71691	·1	18·63398	·1	20·73127
·2	13·40535	·2	15·00127	·2	16·75356	·2	18·67412	·2	20·77512
·3	13·43580	·3	15·03475	·3	16·79028	·3	18·71433	·3	20·81905
·4	13·46631	·4	15·06830	·4	16·82707	·4	18·75461	·4	20·86306
·5	13·49688	·5	15·10191	·5	16·86393	·5	18·79496	·5	20·90715
·6	13·52751	·6	15·13559	·6	16·90086	·6	18·83539	·6	20·95132
·7	13·55820	·7	15·16933	·7	16·93785	·7	18·87589	·7	20·99557
·8	13·58895	·8	15·20313	·8	16·97491	·8	18·91646	·8	21·03990
·9	13·61976	·9	15·23699	·9	17·01204	·9	18·95710	·9	21·08431
175·0	13·65062	180·0	15·27091	185·0	17·04924	190·0	18·99781	195·0	21·12881
·1	13·68155	·1	15·30489	·1	17·08651	·1	19·03859	·1	21·17339
·2	13·71254	·2	15·33893	·5	17·12384	·2	19·07944	·2	21·21805
·3	13·74359	·3	15·37303	·3	17·16124	·3	19·12036	·3	21·26280
·4	13·77470	·4	15·40719	·4	17·19871	·4	19·16135	·4	21·30763
·5	13·80587	·5	15·44142	·5	17·23625	·5	19·20241	·5	21·35254
·6	13·83710	·6	15·47571	·6	17·27386	·6	19·24355	·6	21·39754
·7	13·86839	·7	15·51006	·7	17·31154	·7	19·28476	·7	21·44263
·8	13·89974	·8	15·54448	·8	17·34929	·8	19·32605	·8	21·48780
·9	13·93116	·9	15·57896	·9	17·38710	·9	19·36742	·9	21·53305
176·0	13·96264	181·0	15·61351	186·0	17·42498	191·0	19·40886	196·0	21·57837
·1	13·99416	·1	15·64813	·1	17·46293	·1	19·45038	·1	21·62377
·2	14·02574	·2	15·68281	·2	17·50095	·2	19·49197	·2	21·66924
·3	14·05738	·3	15·71756	·3	17·53904	·3	19·53364	·3	21·71479
·4	14·08909	·4	15·75238	·4	17·57720	·4	19·57539	·4	21·76042
·5	14·12086	·5	15·78726	·5	17·61542	·5	19·61722	·5	21·80612
·6	14·15269	·6	15·82220	·6	17·65371	·6	19·65912	·6	21·85189
·7	14·18457	·7	15·85721	·7	17·69207	·7	19·70110	·7	21·89774
·8	14·21651	·8	15·89228	·8	17·73049	·8	19·74316	·8	21·94367
·9	14·24851	·9	15·92741	·9	17·76898	·9	19·78530	·9	21·98967
177·0	14·28057	182·0	15·96261	187·0	17·80755	192·0	19·82752	197·0	22·03575
·1	14·31269	·1	15·99787	·1	17·84619	·1	19·86982	·1	22·08190
·2	14·34487	·2	16·03319	·2	17·88490	·2	19·91221	·2	22·12813
·3	14·37711	·3	16·06858	·3	17·92368	·3	19·94467	·3	22·17443
·4	14·40941	·4	16·10404	·4	17·96253	·4	19·99720	·4	22·22081
·5	14·44177	·5	16·13957	·5	18·00145	·5	20·03980	·5	22·26726
·6	14·47419	·6	16·17516	·6	18·04044	·6	20·08247	·6	22·31379
·7	14·50667	·7	16·21081	·7	18·07950	·7	20·12521	·7	22·36041
·8	14·53921	·8	16·24653	·8	18·11864	·8	20·16802	·8	22·40711
·9	14·57181	·9	16·28231	·9	18·15785	·9	20·21090	·9	22·45390

TABLE IV.—Table of the Elastic Force or Tension of Aqueous Vapour, &c.—*cont.*

Tension of Vapour in Inches of Mercury for Degrees of Fahrenheit's Thermometer.									
Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.	Therm.	Tension.
198°·0	22·50077	201°·0	23·94648	204°·0	25·46853	207°·0	27·07039	210°·0	28·75571
·1	22·54773	·1	23·99594	·1	25·52061	·1	27·12518	·1	28·81329
·2	22·59478	·2	24·04548	·2	25·57279	·2	27·18007	·2	28·87095
·3	22·64193	·3	24·09511	·3	25·62506	·3	27·23506	·3	28·92870
·4	22·68915	·4	24·14483	·4	25·67742	·4	27·29014	·4	28·98653
·5	22·73646	·5	24·19464	·5	25·72987	·5	27·34532	·5	29·04444
·6	22·78386	·6	24·24454	·6	25·78242	·6	27·40060	·6	29·10243
·7	22·83134	·7	24·29453	·7	25·83506	·7	27·45597	·7	29·16050
·8	22·87891	·8	24·34461	·8	25·88779	·8	27·51144	·8	29·21865
·9	22·92656	·9	24·39478	·9	25·94062	·9	27·56701	·9	29·27688
199·0	22·97429	202·0	24·44504	205·0	25·99353	208·0	27·62267	211·0	29·33518
·1	23·02211	·1	24·49538	·1	26·04653	·1	27·67843	·1	29·39355
·2	23·07002	·2	24·54581	·2	26·09962	·2	27·73429	·2	29·45199
·3	23·11802	·3	24·59633	·3	26·15280	·3	27·79025	·3	29·51050
·4	23·16611	·4	24·64694	·4	26·20606	·4	27·84631	·4	29·56908
·5	23·21428	·5	24·69764	·5	26·25941	·5	27·90247	·5	29·62773
·6	23·26253	·6	24·74843	·6	26·31285	·6	27·95873	·6	29·68645
·7	23·31086	·7	24·79931	·7	26·36638	·7	28·01508	·7	29·74524
·8	23·35927	·8	24·85027	·8	26·42000	·8	28·07152	·8	29·80409
·9	23·40776	·9	24·90132	·9	26·47371	·9	28·12805	·9	29·86300
200·0	23·45633	203·0	24·95246	206·0	26·52751	209·0	28·18467	212·0	29·92196
·1	23·50498	·1	25·00368	·1	26·58140	·1	28·24137	·1	29·98100
·2	23·55371	·2	25·05499	·2	26·63538	·2	28·29816	·2	30·04009
·3	23·60252	·3	25·10638	·3	26·68945	·3	28·35504	·3	30·09925
·4	23·65141	·4	25·15786	·4	26·74360	·4	28·41201	·4	30·15847
·5	23·70038	·5	25·20943	·5	26·79784	·5	28·46907	·5	30·21774
·6	23·74944	·6	25·26108	·6	26·85217	·6	28·52622	·6	30·27707
·7	23·79858	·7	25·31282	·7	26·90658	·7	28·58346	·7	30·33646
·8	23·84780	·8	25·36464	·8	26·96110	·8	28·64079	·8	30·39590
·9	23·89710	·9	25·41654	·9	27·01570	·9	28·69821	·9	30·45539

TABLE V.

TABLE of GREENWICH FACTORS from the published Results for 1857.

Reading of the Dry Bulb Thermometer.	Factor.	Reading of the Dry Bulb Thermometer.	Factor.	Reading of the Dry Bulb Thermometer.	Factor.	Reading of the Dry Bulb Thermometer.	Factor.	Reading of the Dry Bulb Thermometer.	Factor.	Reading of the Dry Bulb Thermometer.	Factor.
20°	8·1	32°	3·3	44°	2·2	56°	2·0	68°	1·8	80°	1·7
21	7·9	33	3·0	45	2·2	57	1·9	69	1·8	81	1·7
22	7·6	34	2·8	46	2·1	58	1·9	70	1·8	82	1·7
23	7·3	35	2·6	47	2·1	59	1·9	71	1·8	83	1·7
24	6·9	36	2·5	48	2·1	60	1·9	72	1·8	84	1·7
25	6·5	37	2·4	49	2·1	61	1·9	73	1·8	85	1·7
26	6·1	38	2·4	50	2·1	62	1·9	74	1·7	86	1·7
27	5·6	39	2·3	51	2·0	63	1·9	75	1·7	87	1·6
28	5·1	40	2·3	52	2·0	64	1·9	76	1·7	88	1·6
29	4·6	41	2·3	53	2·0	65	1·8	77	1·7	89	1·6
30	4·2	42	2·2	54	2·0	66	1·8	78	1·7	90	1·6
31	3·7	43	2·2	55	2·0	67	1·8	79	1·7		

TABLE VI.

Quantity of Water in Snow.

Computed from Experiments made at Kingston, Canada West, (see next page), from which it appears that One Cubic Foot of Snow, as it falls, is equal to 288 Cubic Inches of Water.

Tenths and Inches of Snow.	Ratio to One Inch of Rain expressed Decimally.	Tenths and Inches of Snow.	Ratio to One Inch of Rain expressed Decimally.	Tenths and Inches of Snow.	Ratio of One Inch of Rain expressed Decimally.	Tenths and Inches of Snow.	Ratio to One Inch of Rain expressed Decimally.
	Inches.		Inches.		Inches.		Inches.
0·1	0·0167	3·1	0·5167	6·1	1·0167	9·1	1·5167
·2	0·0333	3·2	0·5333	6·2	1·0333	9·2	1·5333
·3	0·0500	3·3	0·5500	6·3	1·0500	9·3	1·5500
·4	0·0667	3·4	0·5667	6·4	1·0667	9·4	1·5667
·5	0·0833	3·5	0·5833	6·5	1·0833	9·5	1·5833
·6	0·1000	3·6	0·6000	6·6	1·1000	9·6	1·6000
·7	0·1167	3·7	0·6167	6·7	1·1167	9·7	1·6167
·8	0·1333	3·8	0·6333	6·8	1·1333	9·8	1·6333
·9	0·1500	3·9	0·6500	6·9	1·1500	9·9	1·6500
1·0	0·1667	4·0	0·6667	7·0	1·1667	10·0	1·6667
1·1	0·1833	4·1	0·6833	7·1	1·1833	10·1	1·6833
1·2	0·2000	4·2	0·7000	7·2	1·2000	10·2	1·7000
1·3	0·2167	4·3	0·7167	7·3	1·2167	10·3	1·7167
1·4	0·2333	4·4	0·7333	7·4	1·2333	10·4	1·7333
1·5	0·2500	4·5	0·7500	7·5	1·2500	10·5	1·7500
1·6	0·2667	4·6	0·7667	7·6	1·2667	10·6	1·7667
1·7	0·2833	4·7	0·7833	7·7	1·2833	10·7	1·7833
1·8	0·2000	4·8	0·8000	7·8	1·3000	10·8	1·8000
1·9	0·3167	4·9	0·8167	7·9	1·3167	10·9	1·8167
2·0	0·3333	5·0	0·8333	8·0	1·3333	11·0	1·8333
2·1	0·3500	5·1	0·8500	8·1	1·3500	11·1	1·8500
2·2	0·3667	5·2	0·8667	8·2	1·3667	11·2	1·8667
2·3	0·3833	5·3	0·8833	8·3	1·3833	11·3	1·8833
2·4	0·4000	5·4	0·9000	8·4	1·4000	11·4	1·9000
2·5	0·4167	5·5	0·9167	8·5	1·4167	11·5	1·9167
2·6	0·4333	5·6	0·9333	8·6	1·4333	11·6	1·9333
2·7	0·4500	5·7	0·9500	8·7	1·4500	11·7	1·9500
2·8	0·4667	5·8	0·9667	8·8	1·4667	11·8	1·9667
2·9	0·4833	5·9	0·9833	8·9	1·4833	11·9	1·9833
3·0	0·5000	6·0	1·0000	9·0	1·5000	12·0	2·0000

Allahabad Cho

RESULTS of EXPERIMENTS upon the CONVERSION of ICE and SNOW into WATER, at KINGSTON, CANADA WEST, 28th February 1854.

Cubic Content of Snow or Ice.	Weight. Lbs.	Weight. oz.	Description or Character of Snow or Ice.	Temperature under which Dissolution took place. Fahrenheit.	Quantity of Water yielded.	REMARKS.
SNOW.						
1 Foot cube - - -	14	4	As it fell - - - - -	52° - - -	$\frac{1}{6}$ cubic foot.	The whole of the experiments were conducted with great care and exactness.
1 do. - - - -	21	4	24 hours after falling; subsequent average atmospheric temperature 8° Fahr.	52° - - -	$\frac{5}{16}$ do.	Present: Lieut.-Col. Gordon, Lieut. Farrell, Lieut. The Hon. J. Bury, and Lieut. Cox, Royal Engineers.
1 do. - - - -	28	10	72 hours after falling; average temperature 30° Fahr.	52° - - -	$\frac{1}{3}$ do.	
ICE.						
1 Foot cube - - -	57	0	Average temperature, zero - -	52° - - -	$\frac{7}{8}$, or 1512 cubic inches, or 54 lbs. weight of *water*.	So pure and transparent was the ice that manuscript was perfectly legible through it.
SNOW (VIRGIN).						
1 Foot cube, or 1728 inches	63	14	Taken up soon after falling, and compressed into a cubic vessel; temperature, 19°·50 Fahr.	52° - - -	1,728$\frac{1}{4}$ cubic inches, and weight of water produced is 1021 oz. or 63 lbs. 13 oz.	This is an important experiment and result, which complete a series affording very correct data.

TABLE VII.

FIGURES TO DENOTE THE FORCE OF THE WIND.

			Pressure in lbs. per square foot.
0 Denotes Calm.			
1. Light air	just sufficient to give steerage way..................		$\frac{1}{4}$
2. Light breeze.....	with which a well-conditioned man-of-war, under all sail and clean full, would go in smooth water, from...	1 to 2 knots.............	1
3. Gentle breeze....		3 to 4 knots.............	$2\frac{1}{4}$
4. Moderate breeze		5 to 6 knots.............	4
5. Fresh breeze....,	in which the same ship could just carry close hauled	Royals, &c.	$6\frac{1}{4}$
6. Stormy breeze...		Single-reefs and top-gallant sails	9
7. Moderate gale...		Double-reefs, jib, &c.	$12\frac{1}{4}$
8. Fresh gale........		Triple-reefs, courses, &c.	16
9. Strong gale.......		Close-reefs and courses	$20\frac{1}{4}$
10. Whole gale	with which she could only bear.................	Close-reefed main topsail and reefed foresail	25
11. Storm	with which she would be reduced to	Storm stay-sails	$30\frac{1}{4}$
12. Hurricane	to which she could show	No canvas	36

N.B.—The above modes of expression are adopted in Her Majesty's ships and vessels.

TABLE VIII.

Velocity and Pressure of the Wind.

The Pressure varies as the Square of the Velocity, or $P \propto V^2$. The Square of the Velocity in Miles per Hour multiplied by ·005 gives the Pressure in lbs. per square Foot, or $V^2 \times \cdot 005 = P$. The Square Root of 200 Times the Pressure equals the Velocity or $\sqrt{200 \times P} = V$.

The subjoined Tables are calculated from this data.

Pressure in lbs. per Square Foot.	Velocity in Miles per Hour.	Pressure in lbs. per Square Foot.	Velocity in Miles per Hour.	Pressure in lbs. per Square Foot.	Velocity in Miles per Hour.	Pressure in lbs. per Square Foot.	Velocity in Miles per Hour.	Pressure in lbs. per Square Foot.	Velocity in Miles per Hour.
oz.		lbs.		lbs.		lbs.		lbs.	
0·08	1·000	6·75	36·742	17·75	59·581	28·75	75·828	39·75	89·162
0·25	1·767	7·00	37·416	18·00	60·000	29·00	76·157	40·00	89·442
0·50	2·500	7·25	38·078	18·25	60·415	29·25	76·485	40·25	89·721
0·75	3·061	7·50	38·729	18·50	60·827	29·50	76·811	40·50	90·000
1·00	3·535	7·75	39·370	18·75	61·237	29·75	77·136	40·75	90·277
2·00	5·000	8·00	40·000	19·00	61·644	30·00	77·459	41·00	90·553
3·00	6·123	8·25	40·620	19·25	62·048	30·25	77·781	41·25	90·829
4·00	7·071	8·50	41·231	19·50	62·449	30·50	78·102	41·50	91·104
5·00	7·905	8·75	41·833	19·75	62·849	30·75	78·421	41·75	91·378
6·00	8·660	9·00	42·426	20·00	63·245	31·00	78·740	42·00	91·651
7·00	9·354	9·25	43·011	20·25	63·639	31·25	79·056	42·25	91·923
8·00	10·000	9·50	43·588	20·50	64·031	31·50	79·372	42·50	92·195
9·00	10·606	9·75	44·158	20·75	64·420	31·75	79·686	42·75	92·466
10·00	11·180	10·00	44·721	21·00	64·807	32·00	80·000	43·00	92·736
11·00	11·726	10·25	45·276	21·25	65·192	32·25	80·311	43·25	93·005
12·00	12·247	10·50	45·825	21·50	65·574	32·50	80·622	43·50	93·273
13·00	12·747	10·75	46·368	21·75	65·954	32·75	80·932	43·75	93·541
14·00	13·228	11·00	46·904	22·00	66·332	33·00	81·240	44·00	93·808
15·00	13·693	11·25	47·434	22·25	66·708	33·25	81·547	44·25	94·074
		11·50	47·958	22·50	67·082	33·50	81·853	44·50	94·339
lbs.		11·75	48·476	22·75	67·453	33·75	82·158	44·75	94·604
1·00	14·142	12·00	48·989	23·00	67·823	34·00	82·462	45·00	94·868
1·25	15·811	12·25	49·497	23·25	68·190	34·25	82·764	45·25	95·131
1·50	17·320	12·50	50·000	23·50	68·556	34·50	83·066	45·50	95·393
1·75	18·708	12·75	50·497	23·75	68·920	34·75	83·366	45·75	95·655
2·00	20·000	13·00	50·990	24·00	69·282	35·00	83·666	46·00	95·916
2·25	21·213	13·25	51·478	24·25	69·641	35·25	83·964	46·25	96·176
2·50	22·360	13·50	51·961	24·50	70·000	35·50	84·261	46·50	96·436
2·75	23·452	13·75	52·440	24·75	70·356	35·75	84·557	46·75	96·695
3·00	24·494	14·00	52·915	25·00	70·710	36·00	84·852	47·00	96·953
3·25	25·495	14·25	53·385	25·25	71·063	36·25	85·146	47·25	97·211
3·50	26·457	14·50	53·851	25·50	71·414	36·50	85·440	47·50	97·467
3·75	27·386	14·75	54·313	25·75	71·763	36·75	85·732	47·75	97·724
4·00	28·284	15·00	54·772	26·00	72·111	37·00	86·023	48·00	97·979
4·25	29·154	15·25	55·226	26·25	72·456	37·25	86·313	48·25	98·234
4·50	30·000	15·50	55·677	26·50	72·801	37·50	86·602	48·50	98·488
4·75	30·822	15·75	56·124	26·75	73·143	37·75	86·890	48·75	98·742
5·00	31·622	16·00	56·568	27·00	73·484	38·00	87·177	49·00	98·994
5·25	32·403	16·25	57·008	27·25	73·824	38·25	87·434	49·25	99·247
5·50	33·166	16·50	57·445	27·50	74·161	38·50	87·749	49·50	99·498
5·75	33·911	16·75	57·879	27·75	74·498	38·75	88·034	49·75	99·749
6·00	34·641	17·00	58·309	28·00	74·833	39·00	88·317	50·00	100·000
6·25	35·355	17·25	58·736	28·25	75·166	39·25	88·600		
6·50	36·055	17·50	59·160	28·50	75·498	39·50	88·881		

TABLE IX.

Form of Daily Work for Meteorological Observations.

Local time of taking the observations 9h. 30m. Halifax, N.S. 18 .

Barometer.

Barometer		Attached Thermometer.		Results.
Observed reading of barometer No. 72......	=30·078			
Correction for index-error	= + ·031	Observed reading.........	=50·7	
Reading equal standard..	=30·109	*Correction* for index-error	= 0·0	
Correction to reduce to 32°	= — ·060			
True readings	=30·049	....	50·7	30·049...50·7

Thermometers.

Maximum.		Minimum.		Results.
Max. in Sun's Rays, No. 926.		*Min. on Grass, No.* 905.		
Observed reading.............	=63·5	Observed reading	=43·0	
Cor. for index-error	= 0·0	*Cor.* for index-error	= 0·0	
True reading	=63·5	....	43·0	63·5...43·0
Max. in Air, No. 645.		*Min. in Air, No.* 301.		
Observed reading	=53·0	Observed reading.........	=45·9	
Cor. for index-error	= 0·0	*Cor.* for index-error	= 0·0	
True readings..................	=53·0	....	45·9	53·0...45·9

Approximate Mean Temperature of Air.

Max. true reading from No. 645 = 53·0
Min. do. do. No. 301 = 45·9

2)98·9

Approximate mean temperature = 49·4 .... 49·4

Maximum.		Minimum.		Results.
Max. in Wet, No. 56.		*Min. in Wet, No.* 32.		
Observed reading	= ~~49·4~~	Observed reading.........	=45·3	
Cor. for index-error.........	= + 0·5	*Cor.* for index-error......	= 0·0	
True readings................	= 49·9	....	45·3	49·9...45·3

Approximate Mean Temperature in Wet.

Max. true reading from No. 56 = 49·9
Min. do. do. No. 32 = 45·3

2)95·2

Note.—The max. and min. instruments are read at 9.30 a.m. only.

Approximate mean temperature = 47·6 .... 47·6

Hygrometric Readings.	Results.
Dry Bulb, No. 301. Observed reading of min. in air (spirit) ....=51·0; *Cor.* for index-error ....= 0·0 — *Wet Bulb, No.* 32. Observed reading of min. in wet (spirit) ....=47·0; *Cor.* for index-error.......= 0·0	
True readings.................=51·0.................................=47·0	51·0...47·0
Dew-Point computed from Greenwich Factors. True reading of min. in air=51·0; Do. do. in wet=47·0; Difference....................= 4·0; Factor from Table V. p. 28 = 2·1; Product........................= 8·40 — For Dr. Apjohn's formula, see page 24 of Instructions.	
Dew-Point ....=42·6...Dew-Point............................	42·6
Elastic force of vapour = ·273	·273
Humidity.................. = ·730	·730
Wind.	
Direction..................=N.W.	N.W.
Force ....= 0·1	0·1
Rain.	
Total quantity of rain "on ground" for the 24 hours previous to 9.30 a.m. ....= ·000	·000
Total quantity of rain 18ft. 6in. above ground for the 24 hours previous to 9.30 a.m. ....= ·000	·000

Computations by

Observations taken by

[illegible]

Allahabad Christian College

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